Evaluation of Sweetpotato Cultivars with Varying Canopy Architectures in Conventional and a Reduced-tillage Rye Production System

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SUMMARY. Field studies were conducted in North Carolina in 2019 and 2020 to determine the effect of a reduced-tillage, high-residue rye (*Secale cereal*) cover crop system on soil health, and growth and storage root yield of sweetpotato (*Ipomoea batatas*) cultivars having upright (NC04-0531 or NC15-650) or prostrate (Covington or Bayou Belle) vining characteristics. Sweetpotato canopy width expanded quicker in the conventional tillage system than the reduced-tillage rye system. Prostrate sweetpotato cultivars had greater late-season canopy widths than upright cultivars. Soil bulk density of raised beds was greatest in the reduced-tillage rye system, but both systems remained within the U.S. Department of Agriculture recommended range for soil bulk density. The conventional-tillage system resulted in 17% more marketable roots; however, no differences were observed in total marketable root weight between systems. ‘Covington’ and ‘NC15-650’ had greater marketable yield than ‘NC04-0531’ but less marketable yield than ‘Bayou Belle’.

Approximately 150,000 acres of sweetpotato (*Ipomoea batatas*), with a farm gate value of ≈\$600 million, were produced in the United States in 2018 [U.S. Department of Agriculture (USDA), National Agriculture Statistics Service (NASS), 2019]. Sweetpotato growers in North Carolina produce ≈66% of U.S. sweetpotato, with the majority of the remaining U.S. acreage in Mississippi, California, Louisiana, Florida, and Arkansas (USDA-NASS, 2019). Sweetpotato is an economically important crop commodity for these states.

Conventional sweetpotato production systems lead to high levels of

erosion with an estimated soil loss of 49 t·ha⁻¹ (Bloodworth and Lane, 1994). Severe erosion is caused by the reliance on tillage for crop management and weed control. Before transplanting, the soil is disked and raised beds are formed using a tractor-mounted ripper bedder (Treadwell et al., 2007), followed by an average of three cultivations during the growing season to control weeds, and then the soil is turned over during harvest using a tractor-mounted implement with large disk turning plows (Beam et al., 2018). Tillage is a requirement in current sweetpotato production systems but is detrimental to soil structure and decreases soil organic matter content (Hou et al., 2012).

In other crops, such as cotton (*Gossypium hirsutum*), corn (*Zea mays*), and

soybean (*Glycine max*), cover crops are used to reduce reliance on cultivation while increasing soil health. Planting into a rye (*Secale cereal*) cover crop mulch can increase soil organic matter content (DeLaune et al., 2019; Moore et al., 2014), decrease compaction over the long-term (>10 years) (Blanco-Canqui et al., 2010; DeLaune et al., 2019), and reduce nutrient runoff by increasing water infiltration and soil water storage, and storage of residual nitrate in residue (DaLaune et al., 2019; Hartwig, 1988; Kessavalou and Walters, 1999; Langdale and Leonard, 1983).

High-residue rye cover crop mulch in sweetpotato production has the potential to reduce the need for and impact of tillage. Treadwell et al. (2007) reported similar yield between conventional tillage compared with reduced-tillage sweetpotato grown in a rye mulch system in 2 of 3 years in North Carolina. However, this system-based study had varying nitrogen (N) sources as well as levels of weed interference. Similarly, the use of a wheat (*Triticum aestivum*) straw mulch reduced weed biomass without a significant effect on sweetpotato yield in an organic production system in Tennessee (Nwosisi et al., 2019).

Along with altered production systems, sweetpotato cultivars with varying canopy architectures have potential to reduce in-season cultivation for weed control. Under season-long weed interference, ‘Carolina Bunch’ (upright architecture) had greater storage root yield than ‘Beauregard’ (prostrate architecture) in 2 of 3 years (Harrison and Jackson, 2011). Additionally, weeds competing with ‘Carolina Bunch’ tended to have less biomass than those competing with ‘Beauregard’, suggesting that upright sweetpotato cultivars could be better suited to compete with weeds (Harrison and Jackson, 2011).

Information in the peer-reviewed literature is limited with respect to

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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
0.3048	ft	m	3.2808
0.0929	ft ²	m ²	10.7639
2.54	inch(es)	cm	0.3937
16.3871	inch ³	cm ³	0.0610
1.1209	lb/acre	kg·ha ⁻¹	0.8922
1.7300	oz./inch ³	g·cm ⁻³	0.5780
2.2417	ton(s)/acre	t·ha ⁻¹	0.4461
(°F – 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

high-residue rye cover crop mulch system on otherwise conventionally managed sweetpotato. Thus, studies were conducted to determine the effect of production systems (reduced-tillage, high-residue rye cover crop mulch; conventional no mulch) on soil bulk density and moisture, and growth and storage root yield of sweetpotato cultivars having different vining (upright or prostrate) characteristics.

Materials and methods

Field studies were conducted at the Horticultural Crops Research Station near Clinton, NC [HCRS (lat. 35.02°N, long. 78.28°W)] and the Cunningham Research Station in Kinston, NC (CURS (lat. 35.30°N, long. 77.57°W)] in 2019, and the Caswell Research Station in Kinston, NC [CARS (lat. 35.27°N, long. 77.61°W)] in 2020. Soils were an Orangeburg (fine-loamy, kaolinitic, thermic Typic Kandiudults), Norfolk (fine-loamy, kaolinitic, thermic Typic Kandiudults), and Kenansville (loamy, siliceous, subactive, thermic Arenic Hapludults) loamy sand at HCRS, CURS, and CAS respectively. Soil organic matter content was <1% and pH 6 to 6.5 at all locations.

Studies were initiated in the fall by disking the entire site. Plots receiving the reduced-tillage rye treatment were then plowed with a ripper bedder to produce 42-inch-wide bedded rows. Plots assigned to receive the conventional treatment were not bedded until June of the following year. ‘Wrens Abruzzi’ cereal rye seeds were then immediately broadcast at 120 lb/acre across the entire study (Table 1). Nitrogen was applied to the entire study area in December (30 lb/acre) and February (60 lb/acre) to maximize rye biomass production. Cereal

rye in conventional plots was killed using glyphosate at 1.24 kg·ha⁻¹ ae on 11 Mar. 2019 and 4 Feb. 2020. Rye in reduced-tillage plots was allowed to natural senesce without chemical termination. One day before planting, nonrooted sweetpotato cuttings were cut from seeds beds located at HCRS and conventional plots were plowed to produce 42-inch-wide bedded rows. Nonrooted sweetpotato cuttings were transplanted into conventional plots, and directly through the standing rye in reduced-tillage plots using a commercial mechanical transplanter (Chechi and Magli, Lehi, UT) calibrated for 1-ft in-row spacing. Phosphorous (60 lb/acre) and potassium (152 lb/acre) were broadcast across the entire study area at 2 weeks after planting. Nitrogen (46.5 lb/acre) was broadcast across the entire study area at 4 weeks after planting. Fertilizer applications were followed by a cultivation event in conventional plots only. Weeds were controlled season long using a combination of herbicides, cultivation, and hand-roguing. The herbicide program used in both systems consisted of 0.9 lb/acre flumioxazin (Valor SX; Valent USA Corp., Walnut Creek, CA) preplant, 0.75 lb/acre clomazone (Command 3ME; FMC Corp., Philadelphia, PA) 0 to 2 d after transplanting (DAP), 0.7 lb/acre S-metolachlor (Dual Magnum; Syngenta Corp, Greensboro, NC) 7 to 10 DAP, and 0.045 lb/acre clethodim (Select Max; Valent USA Corp.) postemergent as needed for emerged grass control. Escaped weeds >8 cm were controlled by hand-roguing across the study, and cultivation was used as needed in conventional plots. To control root-feeding insects, 0.09 lb/acre bifenthrin (Sniper; Loveland Products, Greeley CO) was broadcast across the entire study area at 4 weeks after

planting for control of root feeding insects. Insecticide applications were followed by a cultivation event in conventional plots only.

Treatments included a high-residue, rye cover crop mulch system (reduced-tillage rye system) and a conventional production system. Within each production system, the sweetpotato cultivars Covington, Bayou Belle, NC01-0531, and NC15-650 were evaluated for performance. ‘Covington’ and ‘Bayou Belle’ have low-growing prostrate vine architectures (Yencho et al., 2008). ‘NC04-0531’ and ‘NC15-650’ were bred for organic production and have upright vine architectures. The study was a split-plot design with production system as the whole-plot factor and cultivar as the split-plot factor. Split-plots were three rows each 20 ft long. The first and third rows were border rows. The second was a data collection row. Whole-plots were completely randomized design with four replications.

Data collected included cover crop biomass, soil volumetric water content and bulk density, and sweetpotato canopy height and width, time to canopy closure, and storage root yield and shape. Rye cover crop biomass was collected 1 week after planting (WAP) sweetpotato. To calculate biomass, two 1-m² quadrats were placed randomly within each reduced-tillage rye whole-plot and then all aboveground rye biomass was collected, placed immediately into paper bags, dried at 70 °C for 1 week and then weighed. Sweetpotato canopy height and width, and soil volumetric water content were measured every 2 weeks from 2 to 12 WAP. Sweetpotato canopy height and canopy width were measured at three random points per split-plot from the soil surface at the top of the bed to the uppermost leaf and perpendicular to the row from leaf tip to leaf tip, respectively. Soil volumetric water content was measured to a depth of 12 cm at three random points, along the top of the bed but ≥10 cm from crown of sweetpotato plants, per split-plot using a soil moisture meter (FieldScout TDR 350; Spectrum Technologies, Aurora, IL) soil moisture meter. Soil bulk density was measured at 2 and 10 WAP by collecting 90.6 cm³ of nondisturbed soil per split-plot from the top of the bed to a depth of 5 cm using a core sampler (AMS,

Table 1. Cover crop (cereal rye) seeding, sweetpotato transplant and harvest dates, and cumulative precipitation at the Horticultural Crops Research Station (Clinton NC), Cunningham Research Station (Kinston, NC), and Caswell Research Station (Kinston NC).

Event	Location		
	Horticultural Crops Research Station	Cunningham Research Station	Caswell Research Station
Rye seeding	25 Oct. 2018	29 Nov. 2018	22 Oct. 2019
Sweetpotato planting	3 June 2019	5 June 2019	9 June 2020
Sweetpotato harvest	26 Sept. 2019	24 Sept. 2019	8 Oct. 2020
Cumulative precipitation (cm) ^z	73.86	42.47	64.56

^zPrecipitation for sweetpotato growing season only; 1 cm = 0.3937 inch.

American Falls, ID). Soil was then dried at 70 °C for 1 week and then weighed. Sweetpotato storage roots were harvested 116, 112, and 122 DAP at HCRS, CURS, and CARS, respectively, using a sweetpotato disk plow (Strickland Bros. Enterprises, Spring Hope, NC). Storage roots were collected by hand for each treatment and graded using a high-throughput optical grader (Exeter Engineering, Exeter, CA) into jumbo (> 3.5 inches diameter), US No. 1 (>1.75 inch but <3.5 inches diameter and >3 inches but <9 inches length), canner (>1 inch but <1.75 inch diameter and >2 inch but <7 inches length), and cull (all other roots) (USDA, Agriculture Marketing Service, 2019). Marketable yield was calculated as the sum of jumbo, US No. 1, and canner grades. The optical grader was also used to collect root length to width ratio measurements on all harvested roots.

Homogeneity of variance and normality were determined before analysis of variance (ANOVA) by plotting residuals. Jumbo, canner, and cull root weights and counts were subjected to square root transformation. Storage root length to width ratio was subjected to log transformation. Transformed data were subjected to ANOVA using PROC MIXED (SAS version 9.4; SAS Institute, Cary, NC). Cultivar, production system, and their interaction were treated as fixed effects. Location and whole-plot nested within production system were treated as random effects. When appropriate, means were separated using Tukey's honestly significant difference ($P > 0.05$). Non-linear regression (SAS PROC NLIN) was carried out on least square means, separately by production system, to describe canopy growth of cultivars over time.

The three-parameter logistic model was used to describe the relationship between canopy height and weeks after planting (Smith et al., 2020):

$$Y = a / [(1 + c) \times \exp(-b \times T)], \quad [1]$$

where Y is the sweetpotato canopy height (centimeters), a is the upper asymptote, T is weeks after planting, c and b are constants.

Results

Rye cover crop dry biomass was 6300 kg·ha⁻¹ at CURS and HCRS and 9100 kg·ha⁻¹ at CARS and was consistent with other research in

Table 2. Effects of four sweetpotato cultivars and two production systems on sweetpotato canopy width at 2, 4, and 6 weeks after planting (WAP).

	2 WAP	4 WAP	6 WAP
	Canopy width (cm) ^z		
Cultivar			
Covington	9 a ^y	18 a	62 a
Bayou Belle	12 a	18 a	66 a
NC04-0531	10 a	18 a	42 b
NC15-0650	13 a	20 a	45 b
Production system			
Conventional	12 a	22 a	62 a
Reduced-tillage	10 a	15 b	46 b
rye ^x			

^z1 cm = 0.3937 inch.

^yMeans within a column followed by the same letter are not different according to Tukey's honestly significant difference test of $P < 0.05$.

^xReduced-tillage rye production system consisted of sweetpotato transplanted through a standing rye cover crop onto beds. No in-season cultivation was conducted.

North Carolina (Smith et al., 2011; Yenish et al., 1996).

SOIL MOISTURE. The interaction of production system and cultivar was not significant ($P > 0.05$); therefore, soil volumetric water content was combined across cultivars. Because of rainfall differences, soil volumetric water content data were analyzed by location and measurement timing. Volumetric water content was similar for both systems the majority of each season except during periods of drought (soil volumetric water content <8%) (Table 4). At CURS volumetric water content was greater in the reduced-tillage rye system at 8 WAP. The same trend was observed at HCRS at 10 WAP. These results support the findings of Daigh et al. (2014) who observed similar results in soybean during extreme drought. These data suggest that during periods of drought, reduced-tillage rye cover crop systems may have more plant available water than conventional systems.

SOIL BULK DENSITY. The interaction of production system and cultivar was not significant ($P > 0.05$); therefore, soil bulk density was combined across cultivars. Soil bulk density in the reduced-tillage rye system was 5% and 7% higher than the conventional tillage system at 2 and 10 WAP, respectively (Table 5). Soil bulk density for both systems at each timing was within the recommended range (<1.6 g·cm⁻³) for root growth in a sandy soil (USDA, Natural Resource Conservation Service, 2008). Although soil bulk density increased throughout the season, previous research indicates that long-term decreases in tillage could

have the opposite effect on soil bulk density (Blanco-Canqui et al., 2010; DeLaune et al., 2019)

SWEETPOTATO CANOPY GROWTH. The interaction of production system and cultivar was not significant ($P > 0.05$); therefore, only the main effects of production system and cultivar are presented for canopy width. Early season (0 to 4 WAP) canopy width in conventional and reduced-tillage rye systems was similar regardless of cultivar (Table 2). After lay-by (≈5 WAP), differences began to emerge between cultivars. At 6 WAP, 'Covington' (62 cm) and 'Bayou Belle' (66 cm) had greater canopy width than 'NC04-0531' (42 cm) and 'NC15-0650' (45 cm). As expected, canopy width expansion of upright cultivars was slower than that of prostrate cultivars regardless of system. Averaged across sweetpotato cultivars, the conventional tillage system resulted in sweetpotato with 50% and 65% greater canopy width than the reduced-tillage rye system at 4 and 6 WAP respectively (Table 2).

Production system by cultivar interaction was significant ($P < 0.05$) for sweetpotato canopy height; therefore, separate models were fit for each cultivar by production system combination. The relationship between sweetpotato canopy height and week after planting was described with a logistics model (Table 3, Fig. 1). The models describing canopy height are similar until late in the season. At 10 and 12 WAP, canopy height of prostrate cultivars was greater than that of upright cultivars. All models describing prostrate cultivars have estimated

Table 3. Parameter estimates for the logistic model for sweetpotato canopy height of four sweetpotato cultivars within a conventional or reduced-tillage rye production system.

Cultivar	Production system	Parameter estimates ^z			RMSE	EF
		a (SE)	b (SE)	c (SE)		
Covington	Reduced-tillage rye ^y	99.0 (130)	0.15 (0.07)	10.6 (13.3)	1.86	0.99
	Conventional	84.1 (104)	0.21 (0.14)	12.3 (11.3)	4.38	0.99
Bayou Belle	Reduced-tillage rye	377.0 (3030)	0.15 (0.09)	47.5 (377)	2.92	0.99
	Conventional	86.2 (68.2)	0.25 (0.11)	15.9 (8.2)	3.86	0.99
NC04-0531	Reduced-tillage rye	65.0 (44.8)	0.22 (0.11)	7.9 (3.9)	3.33	0.99
	Conventional	57.0 (10.8)	0.29 (0.06)	9.6 (1.8)	1.94	0.99
NC15-0650	Reduced-tillage rye	51.6 (8.3)	0.35 (0.09)	11.2 (3.9)	2.74	0.99
	Conventional	52.2 (4.7)	0.33 (0.05)	8.9 (1.5)	1.49	0.99

^zLogistic equation: $Y = a / [(1 + c) \times \exp(-b \times T)]$, where Y is the sweetpotato canopy height (centimeters), a is the upper asymptote, T is weeks after planting, c and b are constants.

^yReduced-tillage rye production system consisted of sweetpotato transplanted through a standing rye cover crop onto beds. No in-season cultivation was conducted.

SE = standard error; RMSE = root mean square error; EF = modeling efficiency coefficient.

maximum heights >84 cm. Conversely, models describing upright cultivars have estimated maximum heights of ≤65 cm. Although estimated maximum heights are likely an overestimation of final canopy height,

they provide a basis for quantifying differences in cultivar canopy structure. Prostrate cultivars also tended to have greater late season canopy height in conventional than reduced-tillage rye systems.

Fig. 1. Effect of ‘Covington’ (A), ‘Bayou Belle’ (B), ‘NC04-0531’ (C), and ‘NC15-0650’ (D) sweetpotato cultivars cultivated in conventional or a reduced-tillage rye production system on crop canopy height from 2 to 12 weeks after planting. Data fit to the formula: $Y = a / [(1 + c) \times \exp(-b \times T)]$, where Y is the sweetpotato canopy height, a is the upper asymptote, T is weeks after planting, c and b are constants. Parameter estimates, root mean square error; and modeling efficiency coefficient provided in Table 3; 1 cm = 0.3937 inch.

SWEETPOTATO YIELD. The interaction of cultivar and production system was not significant; therefore, only main effects are presented. The conventional tillage system had 17% more marketable storage roots than the reduced-tillage rye system (Table 6); however, no differences in other root grade counts or yield by weight were observed between the two systems. ‘Bayou Belle’ had 53% and 66% greater marketable yield than ‘Covington’ and ‘NC15-0650’, respectively (Table 7). ‘Covington’ and ‘NC15-0650’ had 100% and 86% greater marketable yield than ‘NC04-0531’. ‘Bayou Belle’ and ‘NC15-0650’ had similar No. 1 yield which was greater than ‘Covington’ and ‘NC04-0531’. ‘Bayou Belle’ also had the greatest cull yield. Storage root counts by cultivar showed a similar trend to yield weights (Table 8).

Production system did not have a significant effect on storage root shape. ‘NC15-0650’ and ‘NC04-0531’ had the greatest length to width ratios (Table 9). ‘Covington’ had a length/width ratio of 1.69, which is much smaller than the 2 to 1 length/width ratio typical of this cultivar (Yencho et al., 2008).

Conclusion

Sweetpotato grown in the conventional system performed better overall than those grown in the reduced-tillage rye system. Sweetpotato plants had greater canopy growth and produced more storage roots in the conventional system. The differences observed in canopy growth have significant implications for weed management. Large crop canopies are better able to compete for light than small canopies (Seavers

Table 4. Soil volumetric water content at the Cunningham Research Station (Kinston, NC), Horticultural Crops Research Station (Clinton, NC), and Caswell Research Station (Kinston, NC) from 2 to 10 weeks after planting (WAP) sweetpotato into a conventional or reduced-tillage rye production system.

Production system	Cunningham Research Station					Horticultural Crops Research Station					Caswell Research Station				
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
	Soil volumetric water content (%)														
Conventional	14.4 a ^z	9.2 a	13.3 a	2.7 a	4.0 b	13.2 a	16.2 a	12.1 a	3.0 b	16.3 a	21.2 a	11.3 a	—	13.4 a	13.2 a
Reduced-tillage rye ^y	14.0 a	7.2 a	14.5 a	4.2 a	7.8 a	13.3 a	14.9 a	13.9 a	6.9 a	19.3 a	18.3 a	17.6 a	—	15.5 a	14.0 a

^zMeans within a column followed by the same letter are not different according to Tukey's honestly significant difference test of $P < 0.05$.

^yReduced-tillage rye production system consisted of sweetpotato transplanted through a standing rye cover crop onto beds. No in-season cultivation was conducted.

Table 5. Effect of conventional or a reduced-tillage rye sweetpotato production system on soil bulk density at 2 and 10 weeks after planting (WAP).

Production system	2 WAP	10 WAP
	Soil bulk density ($\text{g}\cdot\text{cm}^{-3}$) ^z	
Conventional	1.35 a ^y	1.49 a
Reduced-tillage rye ^x	1.42 b	1.59 b

^z1 $\text{g}\cdot\text{cm}^{-3}$ = 0.5780 oz/inch³.

^yMeans within a column followed by the same letter are not different according to Tukey's honestly significant difference test of $P \leq 0.05$.

^xReduced-tillage rye production system consisted of sweetpotato transplanted through a standing rye cover crop onto beds. No in-season cultivation was conducted.

Table 6. Effect of conventional or a reduced-tillage rye production system on sweetpotato marketable storage root count.

Production system	Marketable storage root (no./ha) ^z
Conventional tillage	66,700 a ^y
Reduced-tillage rye ^x	56,800 b

^zMarketable root count was calculated as total of all roots minus cull roots; 1 root/ha = 0.4047 root/acre.

^yMeans within a column followed by the same letter are not different according to Tukey's honestly significant difference test of $P \leq 0.05$.

^xReduced-tillage rye production system consisted of sweetpotato transplanted through a standing rye cover crop onto beds. No in-season cultivation was conducted.

Table 7. Effect of four sweetpotato cultivars on sweetpotato storage root yield by grade.

Cultivar	Marketable ^z	US No. 1 ^z	Jumbo ^z	Canner ^z	Cull ^z
	Storage root yield ($\text{kg}\cdot\text{ha}^{-1}$) ^y				
Covington	22,300 b ^x	12,000 b	7,740 b	830 bc	780 b
Bayou Belle	34,100 a	18,000 a	13,300 a	1,160 ab	1,400 a
NC04-0531	11,100 c	8,500 b	1,870 c	750 c	330 c
NC15-0650	20,600 b	17,100 a	1,490 c	1,610 a	370 bc

^zMarketable root yield was calculated as total yield minus the cull yield. Jumbo roots are >3.5 inches in diameter, US No. 1 roots are >1.75 inch but <3.5 inches diameter and >3 inches but <9 inches in length, and canner roots are >1 inch but <1.75 inch diameter and >2 inch but <7 inches in length. Cull roots are misshapen or otherwise unmarketable; 1 inch = 2.54 cm.

^y1 $\text{kg}\cdot\text{ha}^{-1}$ = 0.8922 lb/acre.

^xMeans within a column followed by the same letter are not different according to Tukey's honestly significant difference test of $P \leq 0.05$.

Table 8. Effect of four sweetpotato cultivars on sweetpotato storage root count by grade.

Cultivar	Marketable ^z	US No. 1 ^z	Jumbo ^z	Canner ^z	Cull ^z
	Storage roots (no./ha) ^y				
Covington	56,800 b ^x	43,900 b	11,200 b	14,000 bc	7,320 ab
Bayou Belle	84,900 a	65,800 a	17,500 a	19,000 ab	9,590 a
NC04-0531	36,700 c	33,200 b	2,710 c	12,200 c	3,910 b
NC15-0650	68,600 ab	65,300 a	2,660 c	25,600 a	4,090 b

^zMarketable root yield was calculated as total yield minus the cull yield. Jumbo roots are >3.5 inches in diameter, US No. 1 roots are >1.75 inch but <3.5 inches diameter and >3 inches but <9 inches in length, canner roots are >1 inch but <1.75 inch diameter and >2 inch but <7 inches in length. Cull roots are misshapen or otherwise unmarketable; 1 inch = 2.54 cm.

^y1 root/ha = 0.4047 root/acre.

^xMeans within a column followed by the same letter are not different according to Tukey's honestly significant difference test of $P \leq 0.05$.

Table 9. Effect of four sweetpotato cultivars on sweetpotato storage root length to width ratio.

Cultivar	Length to width ratio
Covington	1.69 c ^z
Bayou Belle	1.86 b
NC04-0531	1.92 ab
NC15-0650	2.05 a

^zMeans within a column followed by the same letter are not different according to Tukey's honestly significant difference test of $P \leq 0.05$.

and Wright, 2002). Large canopies can also serve to outcompete later emerging weeds. This suggests that conventional tillage systems result in a more competitive crop than reduced-tillage rye systems. Due to the reduced rate of canopy width expansion of upright cultivars, relative to prostrate cultivars, cultivation to control weeds can occur longer in the season in upright cultivars compared with the prostrate cultivars if grown in a conventional system.

Refinement of reduced-tillage rye sweetpotato production systems is needed before grower adoption. Current methods require additional inputs such as rye seed and off-season fertilizer that is not necessary in conventional production systems. Storage root yield and soil health benefits must be greater in the reduced-tillage rye production system before grower adoption. Future research should focus on methods to decrease input costs and increase yields in reduced-tillage rye production systems.

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