Cultivar Differences in Shear Strength of Okra Pods

Jim E. Wyatt

Emily W. Gatch

Craig H. Canaday

Interpretative Summary

'North and South' and 'Cajun Delight' had high early and late season yields and the highest total yields. 'Burgundy', 'Clemson Spineless', 'Clemson Spineless 80', and 'Perkins Dwarf' had spineless pods. 'Star of David' and 'Silver Queen' had many spines, especially on the apical end of the pods. 'Star of David' and 'Silver Queen' were the easiest pods to remove from the plant. The most difficult to snap by hand were on 'Burgundy', Cajun Delight', and 'Dwarf Long Green Pod'. 'Star of David', 'Clemson Spineless' and 'Clemson Spineless 80' had the highest mean pod weight. On days 5 and 7 after anthesis, 'Burgundy' and 'Perkins Dwarf' did not differ significantly from those that produced the largest pods and also had significantly less shear strength. Most correlations of okra pod length and weight with shear force were significant.

Introduction

Okra pods are edible for a relatively short time after which the pods become too tough and fibrous for consumption. The optimum length for highest quality okra is from two to four inches. Pods of this size are produced approximately three to four days after anthesis under most conditions and have a low shear strength because of little or no fiber present in the pod. Okra for processing can have pods between 3½ and 5 inches long and still have a size classification of "medium" (USDA, 1976). If the time from anthesis to harvest could be extended by cultivar selection without a concomitant loss of quality from excessive fiber, the per-acre yield of okra could be increased.

This study was conducted to determine if okra cultivars differ in rate of development of pod fiber and to identify cultivars that produce large pods with lower shear strength.

Materials and Methods

Eleven okra cultivars and hybrids (hereinafter called "cultivars") were planted at the West Tennessee Experiment Station on May 14, 2003. Prior to planting, Diazinon insecticide at 4 qts/acre, trifluralin herbicide at 1½ pt/acre, and 15-15-15 fertilizer at 300 lbs/acre were broadcast and incorporated.

Each plot was 20 ft long and spaced 5 ft apart. Plots were over seeded and seedlings were thinned to an in-row spacing of about 1 ft. The experimental design was a

randomized complete block with four replications. The test was grown using recommendations for okra production in Tennessee (Sams, 1984). Rainfall was supplemented as needed by drip irrigation.

Harvest began on July 7, 2003. Yield data were obtained by harvesting pods two to five inches long three times weekly for six weeks. Pods from each plot were rated two times for presence or absence of spines. Pods were rated on a subjective scale of 1 to 5 with 1=no spines and 5=many or heavy spines. Ratings were made on 13 and 25 August and data were averaged for analysis.

To obtain pods of known maturity, flowers were tagged on the day of anthesis (DOA) and pods were harvested at one day intervals for four days beginning at DOA + 4. Shear strength was measured on a Model T-1200-G Texture Test System using a Model CS-1 Standard Shear-Compression Cell with 10 blades (Food Technology Corp., Rockville, MD). Individual pods were weighed and the length measured. The "cap" (botanically, the receptacle) was removed and single pods were sheared perpendicular to the direction of the blades. If pods were over 2½ inches long after removal of the cap, the proximal 2½ inches were used for shear measurements.

In an associated study, three pods from each plot were grown for DOA + 6 and rated for ease of removal from the plant. The pods were scored on a scale of 1 to 5 with 1 = stem snapped easily and 5 = stem required cutting. Pods were weighed, seeds and placental tissue removed, and the remaining pod wall weighed. Pod walls were dried overnight at 100EC and dry weights were obtained.

Correlations of pod length with weight, pod length with shear force, and pod weight with shear force were calculated for each cultivar and with each pod age. Replicated data from plots were converted to per-acre yields and subjected to analysis of variance (ANOVA) using appropriate SAS procedures (SAS Institute Inc., Cary, N.C.). Means were separated using Duncan's multiple range test at *P*#0.05, where applicable.

Results and Discussion

'North and South' and 'Cajun Delight' had the highest yields in the study (Table 1). They were also either the highest yielding cultivar in both the early and late portion of the harvest season, or were not significantly different from the highest yielding cultivar. The lowest yielding cultivars, 'Burgundy' and 'Star of David', are specialty types unlike most commercial cultivars commonly grown.

'Burgundy', 'Clemson Spineless', 'Clemson Spineless 80', and 'Perkins Dwarf' had no discernible spines on the pods (Table 1) while 'Star of David' and 'Silver Queen' had many spines which were very irritating to bare skin. If spines were present, their occurrence was usually on or near the pod sutures, and were more dense toward the blossom end of the pods.

The easiest pods to remove from the plant were on 'Star of David' and 'Silver Queen' while the most difficult to snap by hand were on 'Burgundy', Cajun Delight', and 'Dwarf Long Green Pod' (Table 1). This is an important characteristic when harvesting because it is much easier and faster to snap off a pod by hand than to cut the stem with a knife.

Table 1. Seasonal yield distribution, total yield, and pod spine ratings of okra cultivars grown at the West Tennessee Experiment Station in 2003.

Cultivar	Yield (lbs/A)			Pod spine rating (1-5)[x]	Po remc score (
	Early[z]	Late[y]	Total		
Cajun Delight	1507a[w]	8142ab	9649ab	2.5e	4.8ab
Burgundy	740f	4737e	5477e	1.0f	4.9a
Star of David	412g	4745e	5157e	3.8b	1.5e
Silver Queen	1102cde	6933bcd	8035bcd	5.0a	1.6e
Clemson Spineless	957def	7831abc	8788bc	1.0f	3.4c
Clemson Spineless 80	1203bcd	7685abc	8888bc	1.0f	2.6d
Dwarf Long Green Pod	885ef	5613de	6498de	3.0cde	4.2abc
Annie Oakley II	1312abc	7392bc	8704bc	3.4bc	3.8c
Green Best	1411ab	6586cd	7997bcd	3.1cd	4.0bc
North and South	1444ab	9043a	10487a	2.6de	4.0bc
Perkins Dwarf	1203bcd	6619bcd	7822cd	1.0f	3.4c

[z]Early = 7/7/03 to 7/21/03

[y]Late = 7/23/03 to 8/27/03

[x]Spine rating: 1=no spines; 5=many or heavy spines. Mean of two ratings.

[w]Means in columns followed by the same letter are not significantly different, Duncan's multiple range test (*P*# 0.05).

Table 2. Early, late, and total season mean okra pod weights from cultivars grown at the West Tennessee Experiment Station in 2003.

Cultivar	Mean pod wt (oz)		
	Early[z]	Late[y]	Season
Cajun Delight	0.49de[x]	0.44f	0.45g
Burgundy	0.53a-e	0.54c	0.53cd
Star of David	0.49cde	0.62a	0.61a
Silver Queen	0.52a-e	0.58ab	0.57abc
Clemson Spineless	0.57ab	0.61a	0.60a
Clemson Spineless 80	0.59a	0.60a	0.59ab
Dwarf Long Green Pod	0.54a-d	0.52cd	0.52de
Annie Oakley II	0.46e	0.45ef	0.45g
Green Best	0.55a-d	0.48de	0.49ef
North and South	0.51a-e	0.48ef	0.48fg
Perkins Dwarf	0.57abc	0.55bc	0.56bcd

[z]Early = 7/7/03 to 7/21/03

[y]Late = 7/23/03 to 8/27/03

[x]Means in columns followed by the same letter are not significantly different, Duncan's multiple range test (*P*# 0.05).

When considering the data on pods harvested for yield, 'Star of David', 'Clemson

Spineless' and 'Clemson Spineless 80' produced the largest pods of all the cultivars in the study (Table 2). During the early part of the season, we were learning about the characteristics of fruit development of the cultivars and were harvesting the 'Star of David' pods too early for optimum yield for this cultivar.

Pods harvested at 4, 5, 6 and 7 days after anthesis were uniform in size within each day but varied among cultivars (Tables 3 and 4). 'Clemson Spineless', Clemson Spineless 80', 'Burgundy', 'Perkins Dwarf', and 'Dwarf Long Green Pod' had the largest pods in the study while 'Star of David', 'Silver Queen', and 'Annie Oakley II' had the smallest pods. This may be useful in selecting cultivars which produce pods which mature quickly and are ready to harvest soon after flowering.

The optimum condition would be to identify cultivars which do not differ significantly from those that produce the largest pods and also have significantly less shear strength. The only cultivars that meet this criteria are 'Burgundy' and 'Perkins Dwarf' on days 5 and 7 after anthesis (Tables 3 and 4).

Table 3. Pod length, weight, and shear strength at four and five days after anthesis.

	Pod measurements, DOA[z] + 4			Pod measurements, DO		
Cultivar	Pod len (cm)	Pod wt (g)	Shear (lbs)	Pod len (cm)	Pod wt (g)	
Cajun Delight	7.2bcd[y]	6.3d	164bc	11.2bc	14.0bc	
Burgundy	9.1a	9.0ab	191ab	14.8a	19.9a	
Star of David	3.8g	6.7cd	121d	5.0f	10.9c	
Silver Queen	5.5f	6.1d	117d	8.0e	12.3c	
Clemson Spineless	7.0cd	10.1a	212a	10.6cd	19.6a	
Clemson Spineless 80	6.6de	9.1a	191ab	10.2cd	19.8a	
Dwarf Long Green Pod	7.8b	8.5abc	198ab	11.9b	19.3a	
Annie Oakley II	6.3e	5.6d	150cd	9.7d	12.3c	
Green Best	7.2bcd	7.2bcd	184abc	10.5cd	13.9bc	

North and South	7.3bc	7.2bcd	167bc	11.2bc	14.5bc	271b
Perkins Dwarf	7.8b	9.0ab	187abc	10.9bcd	17.2ab	265b

[z]Day of anthesis

[y]Means in columns followed by the same letter are not significantly different, Duncan's multiple range test (*P*# 0.05).

Table 4. Pod length, weight, and shear strength at six and seven days after anthesis.

	Pod measurements, DOA[z] + 6			Pod measurements, DO		
Cultivar	Pod len (cm)	Pod wt (g)	Shear (lbs)	Pod len (cm)	Pod wt (g)	
Cajun Delight	14.4bcd[y]	23.0bcd	345bc	18.0cde	37.2b	
Burgundy	19.7a	36.4a	375ab	22.7a	43.1ab	
Star of David	5.5f	13.4e	243d	7.6h	25.3c	
Silver Queen	10.4e	18.2de	285cd	12.4g	25.0c	
Clemson Spineless	13.5cd	30.3ab	405ab	16.8ef	47.6a	
Clemson Spineless 80	13.3cd	30.4ab	436a	17.0ef	49.8a	
Dwarf Long Green Pod	15.9b	30.4ab	397ab	19.3bc	42.7ab	
Annie Oakley II	12.7d	19.0cde	338bc	15.8f	29.3c	
Green Best	14.6bc	26.1bc	369b	17.4de	39.6b	
North and South	14.5bc	23.9bcd	353b	18.4bcd	38.5b	
Perkins Dwarf	15.3b	27.4b	340bc	19.3b	44.3ab	

[z]Day of anthesis

[y]Means in columns followed by the same letter are not significantly different, Duncan's multiple range test (*P*# 0.05).

Correlations of okra pod length and weight with shear force are presented in Tables 5 through 8. Most data are significant to highly significant, indicating an increase in shear force with increased pod length and weight. A few occasions were found where correlations were not significant, but these were not consistent from day to day for the same cultivar.

Table 5. Correlations of okra pod characteristics four days after anthesis.

Cultivar	N	Correlations (Pod size = day of anthesis + 4)		
		Pod length/ Pod weight	Pod length/ Shear force	Pod weig Shear fo
Cajun Delight	12	0.96***	0.84***	0.93***
Burgundy	12	0.58*	0.56*	0.79***
Star of David	12	0.93***	0.97***	0.98***
Silver Queen	12	0.61*	0.72**	0.91***
Clemson Spineless	12	0.89***	0.85***	0.97***
Clemson Spineless 80	12	0.87***	0.88***	0.99***
Dwarf Long Green Pod	12	0.87***	0.79***	0.97***
Annie Oakley II	14	0.81***	0.89***	0.89***
Green Best	12	0.93***	0.93***	0.99***
North and South	12	0.97***	0.93***	0.96***
Perkins Dwarf	12	0.66**	0.49[NS]	0.76**
Total (all cultivars)	134	0.57***	0.70***	0.89***

NS, *, **,***Nonsignificant or significant at *P*# 0.05, 0.01, or 0.001, respectively.

Table 6. Correlations of okra pod characteristics five days after anthesis.

Cultivar	N	Correlations (Pod size = day of anthesis + 5)		
		Pod length/ Pod weight	Pod length/ Shear force	Pod weig Shear fo
Cajun Delight	13	0.92***	0.81***	0.88***
Burgundy	13	0.95***	0.76**	0.85***
Star of David	12	0.95***	0.94***	0.99***
Silver Queen	12	0.85***	0.84***	0.89***
Clemson Spineless	12	0.55*	0.24^{NS}	0.28^{NS}
Clemson Spineless 80	12	0.94***	0.94***	0.96***
Dwarf Long Green Pod	12	0.33^{NS}	0.13^{NS}	0.89***
Annie Oakley II	12	0.83***	0.84***	0.82***
Green Best	12	0.88***	0.83***	0.94***
North and South	12	0.90***	0.07^{NS}	0.13^{NS}
Perkins Dwarf	13	0.68**	0.28^{NS}	0.85***
Total (all cultivars)	135	0.66***	0.51***	0.82***

NS, *, **,***Nonsignificant or significant at *P*# 0.05, 0.01, or 0.001, respectively.

Table 7. Correlations of okra pod characteristics six days after anthesis.

Cultivar	N	Correlations (Pod size = day of anthesis + 6)		
		Pod length/ Pod weight	Pod length/ Shear force	Pod weight/ Shear force
Cajun Delight	12	0.93***	0.84***	0.90***
Burgundy	13	0.98***	0.85***	0.90***
Star of David	12	0.91***	0.89***	0.97***
Silver Queen	13	0.92***	0.84***	0.96***
Clemson Spineless	12	0.90***	0.67**	0.88***
Clemson Spineless 80	13	0.85***	0.79***	0.94***
Dwarf Long Green Pod	12	0.94***	0.92***	0.96***
Annie Oakley II	12	0.96***	0.84***	0.90***
Green Best	13	0.98***	0.93***	0.95***
North and South	12	0.93***	0.84***	0.92***
Perkins Dwarf	13	0.86***	0.57*	0.89***
Total (all cultivars)	137	0.82***	0.62***	0.86***

NS, *, **,***Nonsignificant or significant at *P*# 0.05, 0.01, or 0.001, respectively.

Table 8. Correlations of okra pod characteristics seven days after anthesis.

Cultivar	N	Correlations (Pod size = day of anthesis + 7)		
		Pod length/	Pod length/	Pod wei

		Pod weight	Shear force	Shear force
Cajun Delight	14	0.93***	0.82***	0.85***
Burgundy	13	0.79***	0.32^{NS}	0.69**
Star of David	13	0.81***	0.83***	0.97***
Silver Queen	12	0.89***	0.86***	0.99***
Clemson Spineless	12	0.86***	0.46^{NS}	0.72**
Clemson Spineless 80	12	0.88***	0.67**	0.65*
Dwarf Long Green Pod	13	0.60*	0.42^{NS}	0.93***
Annie Oakley II	14	0.89***	0.86***	0.78***
Green Best	14	0.92***	0.81***	0.82***
North and South	13	0.68**	0.50^{NS}	0.84***
Perkins Dwarf	12	0.81***	0.62*	0.92***
Total (all cultivars)	142	0.67***	0.22***	0.69***
Grand Total (all cultivars & all pod sizes)	548	0.88***	0.79***	0.92***

NS, *, **,***Nonsignificant or significant at *P*# 0.05, 0.01, or 0.001, respectively.

Literature Cited

Sams, David. 1984. Okra Production. The University of Tennessee. P&SS Information Sheet #77.

U. S. Department of Agriculture. 1976. United States standards for grades of okra for processing. U. S. Dept. Agr., Agr. Mktg. Serv., Wash., D. C.

This research represents one season's data and does not constitute recommendations.

After sufficient data is collected over the appropriate number of seasons, final recommendations will be made through research and extension publications.