Fruit Characteristics and Yield of New Okra Hybrids

Arturo Díaz-F., Alfredo S. Ortegón-M., and Jesús Loera-G.

Campo Experimental Río Bravo, INIFAP, Apartado Postal 172, Río Bravo, Tam., México.

ABSTRACT

Present study was conducted to search for new okra [*Abelmoschus esculentus* (L.) Moench] genotypes as alternatives instead 'Clemson Spineless 80' which has been our traditional variety for several years. Okra hybrids, 'PSR33594', 'PSR33494', 'PSR36394', 'PSR3687', 'PSR3l87', 'Green Best', and 'Annie Oakley' were evaluated in Rio Bravo, Tamaulipas, Mexico. The variety 'Clemson Spineless 80' was used as check. Fruit characteristics: pod length, weight per fruit, fruit diameter, greenness, and yield were measured. Superior fruit characteristics were exhibited by 'PSR33594', 'PSR33494', 'PSR36394', and 'PSR3687' with respect to the other genotypes; however, they ranked low in fruit diameter compared to 'Annie Oakley' and 'Clemson Spineless 80'. No very small fruit was produced by any of the genotypes evaluated. 'Green Best' was the only one which did not show fruit longer than 12.7 cm. 'PSR33594' and 'Green Best' hybrids did not produce any chlorotic fruit. The highest yields were registered for 'PSR33594', 'PSR33494', 'PSR36394', and 'PSR3687'.

RESUMEN

Este estudio se efectuó con el propósito de encontrar nuevos genotipos de okra [*Abelmoschus esculentus* (L) Moench] que sirvan como alternativos para el uso de 'Clemson Spineless 80' que ha sido nuestra variedad tradicional por varios años. Los híbridos de okra ' PSR33594', 'PSR36394', 'PSR33494', 'PSR3687', PSR3187', 'Green Best' y 'Annie Oakley' fueron evaluados en Río Bravo, Tamaulipas, México. La variedad 'Clemson Spineless 80' se usó como control. Se evaluaron las siguientes características del fruto: longitud de la vaina, peso, diámetro, intensidad del color verde y rendimiento. Los cultivares 'PSR33594', ' PSR33494', 'PSR36394' y 'PSR3687' presentaron frutos con características superiores en comparación con los otros genotipos; sin embargo, fueron inferiores en lo referente al diámetro del fruto cuando se compararon con 'Annie Oakley' y 'Clemson Spineless 80'. Ninguno de los genotipos evaluados presentó frutos muy pequeños. El genotipo 'Green Best' fue el único que no mostró frutos más largos que 12.7 cm. Los híbridos 'PSR33594' y 'Green Best' no produjeron frutos cloróticos. Los cultivares 'PSR33594', 'PSR33494', 'PSR36394' y 'PSR3687' presentaron los mayores rendimientos.

Additional index words: Abelmosehus esculentus, yield, fruit quality

Okra [*Abelmoschus esculentus* (L.) Moench] has been grown in northern Tamaulipas for about the last 25 years. This is the largest area where this crop is planted in Mexico, but national consumption is very uncommon (Díaz and Leal, 1992). The total okra production is exported to the USA for the fresh, processing, or frozen market.

Most varieties planted are open pollinated and 'Clemson Spineless 80' is the preferred one. Postharvest losses are common because fruit (pod) length and greenness do not meet the standards required for exportation, and some okra producers spend extra labor to reselect the fruit.

New okra hybrids have been recently released, but no information is available on their comparative response. Previous tests have indicated that yield of hybrids 'Annie Oakley', 'Green Best', '1285', and 'Annie Oakley II' were similar to that of 'Clemson Spineless 80' (Guerrero et al., 1993). Díaz and Ortegón (1997) determined those hybrids to be short season and superior in yield, when compared to the same variety.

In addition to yield, fruit quality plays an important role in okra productivity and marketability. Criteria defining fruit quality is not completely clear except for the pod length characteristic, which is indicated by the U. S. Department of Agriculture (Marsh et al., 1990). Wayne et al. (1984) referred to such desirable characteristics in fruit quality as length, diameter, chlorophyll (greenness), mucilage, and fiber content. The South Texas industry or commercial preference is for fruit 8.9-12.7 cm (medium), although smaller fruit is commonly accepted. A specific greenness and fruit diameter are also required, and even they are arbitrarily indicated, very dark and reduced fruit diameter are the most preferred.

Martin et al. (1981) demonstrated that greenness, length, and weight of the fruit were independent characteristics associated with okra genotype. Wayne et al. (1984) reported that greenness of the fruit showed a linear relationship with the amount of nitrogen in the soil. Early plantings (March) were reported to produce a higher number and weight of medium fruit, as compared to those obtained in late plantings (May)

Table 1. Characteristics of okra fruit from eight genotypes, averaged from nine harvests, in Rio Bravo, Tamaulipas, Mexico.

	Fruit characteristics									
	Small (4.4 - 8.9 cm)			Medium (>8.9 but<12.7 cm)			Large (>12.7 cm)			
Genotype	Number of fruits	Weight per ha	Weight per unit	Number of fruits	Weight per ha	Weight per unit	Number of fruits	Weight per ha	Weight per unit	Diameter
	ha^{-1}	kg ha^{-1}	g	ha^{-1}	kg ha^{-1}	g	ha^{-1}	kg ha^{-1}	g	cm
PSR33594	9000a[z]	52.3ab	5.8b	7810a	103.0a	13.2a	4125ab	109.3ab	26.5a	1.52b
PSR33494	5750bc	43.2ab	7.5ab	6178ab	96.8b	15.7a	4545ab	125.1ab	27.5a	1.40bc
PSR36394	7875ab	62.3a	7.9a	7755a	118.2a	15.2a	6517a	145.2a	22.3a	1.25c
PSR3687	4500cd	32.2b	7.2b	6262ab	82.6b	13.2a	2535bc	55.6bc	21.9a	1.40bc
GreenBest	2868cd	25.5b	8.9a	3879cd	67.0bc	17.3a	0.0c	0.0c	0.0c	1.42bc
Annie Oakley	4346cd	45.5ab	10.5a	5323cd	75.5bc	14.2a	3753abc	60.2bc	16.0b	1.70a
C. Spineless 80	2823cd	29.8b	10.6a	3167d	49.1c	15.5a	808bc	15.7c	19.4b	1.70a
PSR3187	2565d	19.7b	7.7ab	2819d	48.8c	17.3a	1037bc	27.2c	26.2a	1.45b

[z]Means followed by letters in common do not differ significantly at the 0.05 level of probability.

where a high number and weight of small fruits were observed (Díaz-F et al., unpublished data). Present study was conducted as a preliminary assay in searching for new okra genotypes that grown under our local conditions and management, may be selected to replace 'Clemson Spineless 80' our traditional variety since almost 20 years.

MATERIALS AND METHODS

The study was conducted in the Rio Bravo, Tamaulipas, Agricultural Experiment Station of the National Institute for Forestry, Agriculture and Livestock Research (INIFAP). Okra hybrids 'PSR33594', 'PSR33494', 'PSR36394', 'PSR3687', 'PSR3187' (Seminins Vegetable Seeds Co., Fleda, Florida), 'Green Best' (Sakata Seed Inc., Morgan Hill, California), 'Annie Oakley' (Peto Seed, Saticoy, California), and the 'Clemson Spineless 80' variety (Baxter Seed Co., Weslaco, Texas) used as a check, were hand-planted at a depth of 5 cm on 21 February 1995 in a clay soil. The experimental plots were fertilized with 60 kg ha^{-1} of nitrogen and 60 kg ha^{-1} of phosphorus before planting. Trifuralin (*a*,*a*,*a*,-trifluoro-2, 6-dinitro-N,N-dipropyl-p-+tolouidine) was applied (preplant) at a rate of 1 kg a.i.ha^{-1} for weed control. The same rate of N as before was applied when okra genotypes were harvested during the first week. The plots was irrigated four times, including one at preplanting. Plots consisted of four rows, 6.0 m long, with rows spaced 0.9 m apart. The study was designed as a randomized complete block, with four replications. Plant density was 50,000 ha^{-1}.

The plots were harvested every other day for a total of 27 times (cuts). Estimation of pod length, number and weight of fruits per ha, weight per unit, diameter and greenness were averaged from nine harvests (May 14, 15, and 31, June 5, 13, 20, 29, and July 3 and 7) of every genotype. Fruit length was classed as very small (<4.4 cm), small (4.4-8.9 cm), medium (>8.9 but <12.7 cm), and large (>12.7 cm) as indicated by Grange (cited by Marsh et al., 1990). A vernier caliper was used to measure fruit diameter. Fruit greenness was classified, based on previous observations in commercial fruit production, as very dark, dark, medium dark, light dark, and chiorotic. Total yield reported included only fruit <12.7 cm in length from all harvests. Data were analyzed by ANOVA (SAS, 1985) and means were separated by Tukey's studentized range test. Relationship of the weight per unit with the number of fruits per ha was obtained by a correlation analysis.

RESULTS AND DISCUSSION

Fruit length, number and weight. Fruits classed as very small were not observed in this study (Table 1). In general, the 'PSR33594', 'PSR36394' and 'PSR33494' hybrids produced larger numbers of small, medium and large fruit than the other genotypes. The same was true for weight of fruit per ha in each class. Within the small fruit, all of the numbered selections tended to have lower average pod weight than the named varieties, which situation was reversed within the large size (except for 'Green Best' which produced no large pods). Average pod weight of medium sized fruit was without differences.

Medium fruit is the most marketable. It comprised 39, 37, 36, 48, 72, 42, 52, and 51 percent of all the fruit produced by genotypes 'PSR33594', 'PSR33494', 'PSR36394', 'PSR3687', 'Green Best', 'Annie Oakley', 'Clemson Spineless 80' and 'PSR3187', respectively. The highest yield, however, were obtained from 'PS'R33594', and 'PSR36394'. As the number of medium fruit per ha decreased, the fruit weight per unit increased, as indicated by the correlation coefficient of r = -0.77. Among all genotypes, 'PSR36394' produced more yield in each size of fruit. No differences were observed among replicates when fruit length, number and weight data, were analyzed.

Fruit diameter. 'Annie Oakley' and 'Clemson Spineless 80' had the largest pod diameter at 1.7 cm. Mostly, all fruit diameters are accepted for exportation, although, there may be some rejection as diameter increases, inasmuch as the industry prefers smaller-diameter fruit (Table 1). A general trend was observed for 'PSR33594', 'PSR33494', and 'PSR36394' in that they produced higher yields and a reduced fruit diameter, when compared to 'Clemson Spineless 80', our local check variety. We consider 'PSR3687', 'Green Best', and 'Annie Oakley' as intermediate in response. Also we consider 'Clemson Spineless 80' and 'PSR3187' to be low in terms of overall yield and fruit size. By contrast, 'Clemson Spineless 80' yielded comparatively similar to 'Annie Oakley', 'Green Best', '1285', and 'Annie Oakley II' when tested over three planting dates in Sonora, Mexico (Guerrero et al., 1993).

Replicates did not show statistical differences.

Fruit Greenness. The percentage of fruit classed as very dark was highest for 'PSR33594' (Table 2). No fruit of this class occurred in 'PSR33494', 'PSR36394', 'Green Best', 'PSR3187' or 'Clemson Spineless 80'. There were no differences among genotypes in the dark green category, with percentages ranging from 10.5 ('Annie Oakley') to 18.1 ('PSR3687'). The same was true for percentage of medium dark fruit, ranging from 23.2 percent ('Annie Oakley') to 40.5 ('PSR36394'). Higher percentages of light dark fruit were observed in 'PSR33494', 'Annie Oakley' and 'Clemson Spineless 80'. While chlorotic fruit were not observed in 'PSR33594' and 'Green Best', the percentage of chlorotic fruit ranged to 5.3 for 'PSR36394'. However, no statistical differences occurred among genotypes. For all cases, when greenness condition data were analyzed, no differences were observed among replicates.

Approximately one-half of all fruit production was of light dark color and the minimum production was observed for very dark and chiorotic fruit in all genotypes. All, except chlorotic is exportable, however, a very dark, dark and medium dark greenness is preferred by industry. Approximately half of the fruits produced by 'PSR33594', 'PSR36394', 'Green Best', and 'PSR3187' ranged from medium dark and dark to very dark. Chlorophyll content in spinach leaves (*Spinaca oleracea* L.) is a key quality factor to be selected in breeding and it is associated with diseases and nutrient deficiencies (Santos, 1992). Martin et al. (1981) demonstrated genotype variation in okra fruit greenness. Wayne et al. (1984) mention that nitrogen fertilization influences fruit greenness. In our study, all genotypes were grown under the same fertilizer conditions, indicating that some other factor is influencing fruit greenness.

Partial and total yield. Yield was estimated in kg ha^{-1} from the total of the 27 harvests (Table 3). A partial yield was recorded for the first 24 harvests. The last three harvests were obtained by subtraction because they were not recorded at harvest time. 'PSR33594' produced a higher yield than the other genotypes when either partial yield or total yield were calculated. 'PSR3494', 'PSR36394', and 'PSR3687' were intermediate in yield, while lowest yield occurred in 'Green Best', 'Annie Oakley', 'PSR3187' and 'Clemson Spineless 80'. Differences among replicates were not observed. Díaz and Ortegón (1997) have reported that hybrids were 3-5 days earlier harvest as compared to 'Clemson Spineless 80'. They also consider (Díaz and Ortegón, 1996) other advantages as those for hybrids 'CM No. 1' or 'Cajun Delight', which were able to emerge under a soil temperature of 17.5°C.

For practical purposes, we may assume from our results, that major marketable characteristics as fruit diameter and greenness, were acceptable in all genotypes. However, as indicated by the total yield obtained with 'PSR33594', 'PSR33494', 'PSR36394', and 'PSR3687' hybrids, they offer a better alternative to increase our actual okra production instead of the local traditional variety, 'Clemson Spineless 80'.

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Table 2. Percentage of okra fruit classed by their greeness from eight genotypes planted in Rio Bravo, Tamaulipas, Mexico

	Greeness (%)				
Genotype	Very Dark	Dark	Medium Dark	Light dark	Chlorotic
PSR33594	14.5a[z]	12.6a	27.3a	45.6b	0.0a
PSR33494	0.0b	12.7a	23.8a	58.0a	4.6a
PSR36394	0.0b	10.7a	40.5a	43.1b	5.3a
PSR3687	1.1b	18.1a	28.3a	47.5b	5.0a
Green Best	0.0b	17.6a	33.8a	48.4b	0.0a
Annie Oakley	2.1b	10.5a	23.2a	60.3a	5.0a
C. Spineless 80	0.0b	14.6a	29.4a	52.8a	4.0a
PSR3187	0.0b	16.1a	38.5a	39.9b	5.2a

[z]Means followed by letters in common do not differ significantly at the 0.05 level of probability.

Table 3. Partial and total yield from eight genotypes of okra planted in Rio Bravo, Tamaulipas, Mexico.

	Yield (kg ha^{-1})		
	Harvests		
Genotype	Partial (First 24 cuts)	Partial (Last 3 cuts)	Total (27 cuts)
PSR33594	9191a[z]	5418	14609a
PSR33494	6022b	2482	8504b
PSR36394	5200b	2734	7934b
PSR3687	4635bc	1138	5773b
Green Best	2612c	340	2952c
Annie Oakley	2679c	208	2887c
C. Spineless 80	2575c	316	2891c
PSR3187	2437c	273	2710c

[z]Means followed by letters in common do not differ significantly at the 0.05 level of probability.

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