

Pepper cultivars on the northwestern coast of Puerto Rico¹

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ABSTRACT

In 1985 and 1986, respectively, 16 and 36 cultivars of peppers were grown in yield tests at Isabela, P. R., in a randomized complete block design with four replicates. Each replicate was a 3.7-m (12-ft) row with 12 plants. Because of *Fusarium* infestation replanting was needed in 1985 and two replicates were lost in 1986. There were no significant differences among cultivars in standcount response to *Fusarium*. There were significant yield differences both years. The highest yielders tended to be, but were not exclusively, hybrids. Frying (Cubanelle) and pimiento types did very well. Among the best standard cultivars were "Staddon's Select", "Jupiter", "Super Stuff" and "Blanco del País". In at least some cases a grower can earn more per area with the right open-pollinated cultivar than with the substantially more expensive hybrids.

RESUMEN

Rendimiento de variedades de pimiento en la costa norte de Puerto Rico

En 1985 y 1986 se establecieron siembras con 16 y 36 variedades de pimiento (*Capsicum annuum* L.), respectivamente, en la Subestación Experimental de Isabela, P. R. en un diseño experimental de bloques completos aleatorizados con cuatro repeticiones cada uno. Cada repetición consistió de 12 plantas en una hilera de 3.7 m., a 30 cm. entre plantas. Debido a la infestación con *Fusarium* fue necesario resembrar en 1985; en 1986 se perdieron dos repeticiones. Entre las plantas sanas y las secas de *Fusarium* no hubo diferencias significativas a base de la variedad. Los híbridos mostraron la tendencia a tener mayor rendimiento, pero no fueron exclusivos. Los tipos Cubanelle y "pimiento" (el nombre inglés de un tipo popular principalmente en el sur de los E.E.U.U.) resultaron ser buenos productores. De las variedades comerciales incluidas, "Staddon's Select", "Jupiter", "Super Stuff" y "Blanco del País" fueron las mejores. En algunas ocasiones los agricultores pueden obtener más ganancia por área sembrando variedades comerciales en vez de híbridos, los cuales son sustancialmente más costosos.

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INTRODUCTION

Peppers (*Capsicum* sp.) were apparently a domesticated crop of the Tainos in the West Indies centuries before the coming of Columbus (5). *C. annuum* L. is one of four major vegetable crops in Puerto Rico today. Approximately 22,679 metric tons (25,000 tons) are produced on the island annually, and an approximately equal amount is imported (1). Both bell and frying ("Cubanelle") types are grown. Bell types predominate among exports, whereas frying types are predominately sold through local markets. About 80% of the peppers produced and virtually all of the export crop are currently grown on the south coast utilizing intensive cultural practices, drip irrigation, fertigation, etc. Predominating soils are well drained Mollisols. Plantings which are generally smaller and less intensively managed can be found on the northwestern coast and in other areas where conditions permit. The northwestern coast is wetter and the soils, mostly Oxisols, are poorer and more leached. Given the continuing decline in area planted to sugarcane and the commonly expressed goal of decreasing the amount of imported food, peppers and other vegetables have potential for increasing in importance on the northwestern coast. Inquiries received by growers as to the best cultivars to plant and the best growing methods support this suggestion.

The objective of this experiment was to test cultivars of various types on the northwestern coast of Puerto Rico. A related project is testing cultivar performance on the south coast and will produce a separate report. Farmers currently choose between purchasing seed of a local sweet frying cultivar, "Blanco del País", sold through AFA (Administración de Fomento Agrícola), or seed of various bell and frying cultivars sold by several companies. Since the few studies on gene effects on pepper yield have consistently shown that additive effects predominate (4,6,8), these results can also serve in choosing the best parents for breeding of locally adapted lines.

MATERIALS AND METHODS

Seed of commercial cultivars was provided in response to a request for material which might do well in the Caribbean, or which carried virus resistance. Several university breeders provided seed of cultivars or lines with virus resistance. Two old cultivars obtained through Seed Savers Exchange³ and of interest for certain fruit traits were also included in 1985-86.

Yield tests were carried out over a 2-year period. At the University of Puerto Rico Agricultural Experiment Station in Isabela, P. R., 21 cultivars were planted in the greenhouse 22 October, 1984, and planted in the field 28 November (table 1). In 1985, 36 cultivars were planted in

³Seed Savers Exchange, P. O. Box 70, Decorah, IA 52101.

TABLE 1.—Pepper cultivars tested in 1984-85, their seed sources, and some characteristics

Cultivar	Source	Type ¹	Hybrid?
Green Boy	Agway Inc.	bell	X
Pip	Asgrow Seed Co.	bell	
Melody	"	bell	X
Skipper	"	bell	X
Lady Bell	Harris-Moran	bell	X
Hybelle	Seed Co., Inc.	bell	X
Key Largo	"	frying	X
Gator Belle	Petoseed Co., Inc.	bell	X
Mercury	"	bell	
Gypsy	"	frying	X
Cubanelle	"	frying	
Early Niagra Giant	Stokes Seed Ltd.	bell	
Staddon's Select	"	bell	
Río Grande Gold	Texas A & M Univ.	intermediate	
TAM Bell	"	bell	
TAM Mild Chili -2	"	chile	
Hidalgo	"	hot pepper	
TAM Mild Jalapeño	"	mild jalapeño	
FLBG-1	Univ. of Florida	frying	
Delray Bell	"	bell	
Blanco del País	AFDA	frying	

¹University material supplied by Dr. R. Subramanya, Univ. of Florida, and Dr. B. Villalon, Texas A & M Univ.

the greenhouse, and in the field 10 October and 25 November, respectively (table 2). After the disease problem described below, cultivars with seed on hand for immediate replanting were planted in the greenhouse and in the field 14 January and 28 February, 1985, respectively. There was not sufficient seed to replant "Blanco del País", Tamber 2, "Hidalgo", FLBG-1 or Delray Bell. Both years, 10-10-10 fertilizer was applied by hand to the side of rows at the rate of 560 kg/ha (500 lb/acre) at transplanting. A second application at the same rate was side-dressed after the first harvest. There were 12 plants per row, 30.5 cm (1 ft) within the row. Rows were 91.5 cm (3 ft) apart. The design was a randomized complete block with four replicates. In 1985, fruits were harvested 18 and 29 April, 15 and 28 May, and 10 and 24 June. In 1986, fruits were harvested 22 January, 4 and 21 February, 12 March, and 18 April.

Both years there were problems with soil fungi, even though these experiments were done in the dry season. A prolonged period of unseasonably wet weather in December 1984 favored soil fungi, diagnosed as *Fusarium* (probably *F. oxysporum*) and *Rhizoctonia solani*.⁴ Many rows lost all plants by 7 January, and the test was completely lost for yield

⁴A. Sánchez-Miranda, personal communication.

TABLE 2.—*Pepper cultivars tested in 1985-86, their seed sources and some characteristics*

Cultivar	Source	Type ¹	Hybrid?
Green Boy	Agway Inc.	bell	X
Early Calwonder	Asgrow Seed Co.	bell	
Skipper	"	bell	X
Melody	"	bell	X
Pip	"	bell	X
Hybelle	Harris-Moran	bell	X
Lady Bell	Seed Co., Inc.	bell	X
Jupiter	Northrup-King Co.	bell	
NVH3053	"	bell	X
P1000	"	bell	X
P1796	"	bell	X
Argo	Petoseed Co., Inc.	bell	X
Gator Belle	"	bell	X
Gypsy	"	frying	X
Hybrid Pacific	"	bell	X
Pimento	"	pimento	
VR-2	"	bell	
Big Bertha	Stokes Seeds Ltd.	bell/frying type	X
Butter Belle	"	bell, yellow	
Early Niagra Giant	"	bell	
Four Corners	"	bell	X
Giant Yellow Banana	"	frying/banana	
Lincoln Bell	"	bell	
Staddon's Select	"	bell	
Super Red	"	pimento, flattened	
Super Shepherd	"	frying, green	
Super Stuff	"	frying, yellow	
Szegedi	"	paprika	
Blanco del País	AFDA	frying	
Del Ray Bell	Univ. of Florida	bell	
FLBG-1	"	frying	
TAM Mild Chili	Texas A & M Univ.	chili	
TAM Bell	"	bell	
Garden Sunshine	Univ. of California	bell, yellow	
Sheepnose	Seed Savers Exch.	pimento	
Nardello's Sweet Ital.	Fryer "	frying, thin	

¹University material supplied by Dr. R. Subramanya, Univ. of Florida, Dr. B. Villalon, Texas A & M Univ., and Dr. A. H. Millett, Univ. of California.

analysis. Standcounts were taken every 2 weeks until 26 March, 1985, to see whether there were any possible genetic differences in response. For the 1985-86 experiment, a higher location was used where no solanaceous crops had been grown for several years. Care was taken to ensure clean transplant, including a Captan drench before transplanting. Nonetheless, several weeks after transplanting, a soil fungi infestation, diagnosed as *Fusarium* (probably *F. oxysporum*) began at the low end of the field and advanced through the course of the experiment. Two

replicates had to be deleted from yield analysis. An analysis of variance was done of standcount from 18 April 1986.

Plots were hand-weeded and insects controlled chemically. The pepper weevil (*Anthonomus eugenii*) was successfully controlled by rotating applications of fenvalerate (Pydrin 2.4EC)⁶ at 0.58 L/ha (8 fl oz/acre), oxamyl (Vydate L) at 2.34 L/ha (2 pt/acre) and methomyl (Nudrin 90 WSP) at 0.56 kg/ha (1.2 lb/acre). No fungicides were used. Overhead irrigation was applied weekly in the absence of rain.

Analysis of variance was done of weight and number of marketable fruit. Causes of non-marketability were noted. Standcounts were taken at each harvest and data adjusted to account for dead plants. In the second 1985 test and in the two replicates of the 1986 test unaffected by soil fungi, there were only occasional dead plants, resulting from movement of irrigation pipes. Date of 50% flowering, plant height to topmost node, and fruit dimensions and characteristics from samples were recorded.

RESULTS AND DISCUSSION

None of the material tested appeared resistant to this *Fusarium* strain. Analysis of standcounts from neither year had statistically significant differences among these genotypes, nor were trends apparent, with the possible exception in 1985 of greater survival of Hidalgo (the only truly hot pepper in the test). Palazon et al. (7) reported that Staddon's Select carried good field resistance to *Verticillium* root rot in Spain. Our results indicate it does not carry resistance to the *Fusarium* present in Puerto Rico.

There were significant yield differences among cultivars (table 3 to 5). The 1985-86 experiment was generally more stressed than that in the 1984-85 environment. This was due both to water management problems and budgetary reductions that allowed less weeding. In the analyses of fruit number (not shown), genotype effects were highly significant both

TABLE 3.—Analyses of variance for fruit yield in kg for pepper cultivars at Isabela, P. R. in 1985 and 1986

Source	1985 D.F.	1985 mean square	1986 D.F.	1986 mean square
Varieties	15	9.75**1	35	175.50*
Replicates	3	5.79**1	1	889.00**
Error	45	1.98	35	101.93

1*, ** denote significance at P = 0.05 and 0.01, respectively.

⁶Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is the mention a statement of preference over other equipment or materials.

TABLE 4.—Pepper cultivars tested in 1985, mean date of 50% flowering, mean yields and ranks on a kg per plot basis and types of virus resistance

Cultivar	X Flwrg. ¹ Date	Kg/plot ² 6 harvests	Rank	Virus resistance ³ or tolerance
<i>Standard Cultivars</i>				
Staddon's Select	35	8.45* ⁴	5	
Pip	30	7.05	10	
TAM Mild Chili -2	30	6.90	11	PVY, TEV, PeMoV, TMV
Cubanelle	31	6.85		
Mercury	29	6.45	13	TMV
Early Niagra Giant	42	6.38	14	
Río Grande Gold S	27	5.20	15	probably segregating
TAM Mild Jalapeño	32	4.08	16	PVY, TEV, TMV
<i>Hybrid Cultivars</i>				
Key Largo	33	9.75*	1	
Gator Belle	31	9.58*	2	
Hybelle	34	9.52*	3	TMV
Green Boy	31	8.65*	4	
Gypsy	28	8.12*	6	TMV
Lady Bell	30	7.80	7	TMV
Skipper	31	7.45	8	PVY, TMV
Melody	31	7.32	9	TMV

¹Denotes days to 50% flowering after transplanting. To obtain days from planting of seeds, add 44.

²Denotes mean of four replicates of 12 plants each at 30.5 cm (1 ft) spacings. To convert to lb/acre, multiply by 667.

³Based on information from the respective company or university researcher. PVY, TEV, PeMoV, TMV refer to Potato Virus Y, Tobacco Etch Virus, Pepper Mottle Virus and Tobacco Mosaic Virus, respectively.

⁴Denotes cultivars not significantly different by one-tailed F-LSD from highest yielding cultivar.

years, as was expected. Replicate effects were significant only in 1985. Means over replicates for fruit number and weight had a correlation in 1985 of -0.57 (significant at $P = 0.05$; 14 d.f.). This correlation was nonsignificant in 1986 ($r = 0.27$; 34 d.f.). Additional data are shown for flowering date (tables 4,5), fruit characteristics and plant height (tables 6, 7). Causes of nonmarketability varied slightly among cultivars, but since pathogens were not uniformly administered, data are only suggestive. All genotypes lost some fruits to the pepper weevil. All lost some fruits to anthracnose (*Colletotrichum phomoides*) with the exception of Río Grande Gold - S and TAM Mild Chili - 2 in 1985, and Pimiento L, Gypsy, Giant Yellow Banana, and Garden Sunshine in 1986. Fruit losses due to bacterial rot (probably a *Xanthomonas* sp.) appeared random and minor.

Although data are limited, it is interesting that hybrids were not always superior to open-pollinated cultivars (tables 4, 5). Staddon's Select had a stable reasonably high yield both years. Jupiter, another open-pollinated bell cultivar, was also outstanding. Reports suggest that

TABLE 5.—*Pepper cultivars tested in 1986, mean date of 50% flowering, mean yields and ranks on a kg per plot basis and types of virus resistance*

Cultivar	X Flwrg. ¹ date	Kg/plot ² 6 harvests	Rank	Virus resistance ³ or tolerance
<i>Standard Cultivars</i>				
Pimiento L	28	6.75* ⁴	1	TMV
Jupiter	28	6.25*	4	TMV
Super Stuff	22	5.55*	10	
Blanco del País	31	5.15*	12.5	
Garden Sunshine	24	5.10*	14	possibly TMV
FLBG-1	31	5.05*	15	PVY, TEV, PeMoV
Staddon's Select	22	5.00	16.5	
Sheepnose	23	4.95	18	
TAM Mild Chili -2	23	4.90	19	PVY, TEV, PeMoV, TMV
Butter Belle	21	4.70	21.5	
Lincoln Bell	22	4.70	21.5	
Super Shepherd	22	4.60	24	
Szegedi	21	4.40	25	CMV
Super Red	26	4.35	26	
VR-2	31	4.30	27	PVY, TEV, TMV
Early Niagra Giant	25	4.30	29	
Giant Yellow Banana	22	4.00	30.5	
TAM Bell	23	3.70	32	PVY, TEV, PeMoV, TMV
Nardello's	20	3.65	33	
Early Calwonder	31	3.45	35	
Del Ray Bell	24	3.05	36	PVY, TEV, PeMoV
<i>Hybrid Cultivars</i>				
Argo	31	6.45*	2	TMV
Gypsy	24	6.35*	3	TMV
P1000	31	6.25*	5	TMV
Gator Belle	24	6.20*	6	
Melody	27	6.00*	7	TMV
P1796	26	5.80*	8.5	TMV
Big Bertha	22	5.80*	8.5	TMV
Four Corners	25	5.30*	11	TMV
Hybrid Pacific	35	5.15*	12.5	
NVH3053	21	5.00	16	TMV
Green Boy	24	4.75	20	
Skipper	24	4.65	23	PVY, TMV
Hybelle	23	4.30	28	TMV
Lady Bell	23	4.00	30.5	TMV
Pip	26	3.55	34	

¹Denotes days to 50% flowering after transplanting. To obtain days from planting of seeds, add 47.

²Denotes mean of two replicates of 12 plants each at 30.5 cm (1 ft) spacings. To convert to lb/acre, multiply by 667.

³Based on information from the respective company or university researcher. PVY, TEV, PeMoV, TMV refer to Potato Virus Y, Tobacco Etch Virus, Pepper Mottle Virus and Tobacco Mosaic Virus, respectively.

⁴Denotes cultivars not significantly different by one-tailed F-LSD from highest yielding cultivar.

TABLE 6.—Pepper cultivars tested in 1985, with means for fruit width, length and weight, and plant height

Cultivar	Fruit width ¹	Fruit length ¹	Fruit weight ²	Plant height ³
<i>Standard Cultivars</i>				
Staddon's Select	6.7 cm	8.5 cm	88 g	30 cm
Pip	6.2	6.5	87	21
TAM Mild Chili-2	3.0	12.7	28	26
Cubanelle	4.5	10.5	39	29
Mercury	6.5	6.2	89	25
Early Niagra Giant	7.0	8.5	78	30
Río Grande Gold-S	3.0	5.8	15	20
TAM Mild Jalapeño	2.8	5.3	11	20
<i>Hybrid Cultivars</i>				
Key Largo	4.8	14.0	60	34
Gator Belle	5.8	7.5	84	27
Hybelle	5.7	7.8	76	25
Green Boy	5.5	7.2	70	24
Gypsy	4.5	9.2	45	30
Lady Bell	6.0	6.7	74	24
Skipper	6.2	7.5	85	26
Melody	5.8	9.5	79	26

¹Mean of samples from first, third and fifth harvest.

²Means over all harvests.

³Height to topmost node at time of first harvest.

much of the genetic variability in peppers for yield is additive in nature (4,6,8). One could thus expect that some standard cultivars would equal or surpass hybrid performance. The 1986 results particularly support this expectation with the qualification that under less stressed conditions the performance of some hybrid cultivars may have been better. On the basis of the price information supplied by participating companies regarding seed costs, hybrid pepper seed and standard cultivar pepper seed cost an average of about \$1,300 and \$50 per kg, respectively, in 1984-86. On the basis of about 0.85 kg/ha for direct seeding (2), the use of hybrid seed would be an additional cost of about \$1,060/ha (\$429/acre). For transplanting, hybrid transplants would cost about \$58 more than standard cultivars per 10,000 plants (on the basis of an average of 21,300 seeds/kg (2)). Recent experiments concerning optimum pepper populations have used ranges from 22,230 to 247,000 plants per ha (9,000 to over 100,000 plants per acre) (3,9); however, the extremes of these studies would not be typical of commercial production fields. The additional cost of using hybrid seed for transplant production could thus range from about \$130 to \$1,430 more per ha (about \$50 to \$580 more per acre). Thus, in some cases a grower could earn more per given area with the right open-pollinated cultivar than with a hybrid.

TABLE 7.—*Pepper cultivars tested in 1986 with means for fruit width, length, and weight, and plant height*

Cultivar	Fruit width ¹	Fruit length ¹	Fruit weight ²	Plant height ³
<i>Standard Cultivars</i>				
Pimiento L	4.5 cm	7.0 cm	57 g	32 cm
Jupiter	7.5	6.0	88	30
Super Stuff	5.5	8.0	45	31
Blanco del País	4.0	7.5	32	25
Garden Sunshine	6.0	6.5	59	26
FLBG-1	4.0	9.0	35	33
Staddon's Select	6.0	5.5	70	26
Sheepnose	5.0	7.5	48	32
TAM Mild Chili-2	3.5	11.0	30	27
Butter Belle	4.5	4.5	49	31
Lincoln Bell	5.5	6.5	60	28
Super Shepherd	5.0	10.0	48	28
Szegedi	5.0	6.5	40	30
Super Red	6.5	3.0	56	28
VR-2	6.5	6.0	61	26
Early Niagra Giant	5.0	6.5	77	35
Giant Yellow Banana	3.0	10.0	31	34
TAM Bell	5.5	8.0	77	27
Nardello's	4.0	14.0	28	32
Early Calwonder	6.0	6.5	72	30
Del Ray Bell	4.0	8.0	66	28
<i>Hybrid Cultivars</i>				
Argo	6.5	9.0	73	33
Gypsy	4.5	8.0	41	30
P1000	7.0	6.5	77	24
Gator Belle	6.5	7.0	82	29
Melody	6.0	6.5	84	33
P1796	7.5	6.0	86	35
Big Bertha	6.0	7.0	89	33
Four Corners	6.0	7.0	74	32
Hybrid Pacific	6.5	7.0	74	30
NVH3053	5.0	6.0	86	29
Green Boy	7.0	3.5	65	25
Skipper	7.0	7.0	82	29
Hybelle	6.5	7.0	69	25
Lady Bell	6.0	6.0	60	28
Pip	6.5	7.5	74	30

¹Mean of three samples from third harvest.

²Mean over all harvests.

³Height to topmost node at time of second harvest.

Sweet frying and pimento types showed good yields and stability under the stressed 1986 conditions. The best yielder in 1985 was a frying pepper. Seed of Key Largo and Cubanelle were not available for inclusion in the 1986 test. All frying cultivars were among the significantly best yielding genotypes in 1986 (table 5). These included the germplasm release FLBG-1 (10) and Blanco del País, a variable Puerto Rican population. Pimento cultivars, a type mainly sold in the U.S. South, also did well. In the 1940's pimentos were an important crop in the Isabela area. Sheepnose performed surprisingly well for being an old cultivar and possibly even a native variety.

Viral resistance or tolerance did not seem consistently associated with yield (tables 4 and 5). No viral symptoms were seen in 1985 until after the fifth harvest, when some plants infected with potato virus Y and/or pepper mottle virus were detected.⁶ In 1986, no virus infections were detected.

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