



Evaluation of Bacterial Spot Resistant Bell Peppers

EUGENE McAVOY^{1*}, KEN PERNEZNY², RUSSELL NAGATA², DARRIN PARMENTER³,
AND DAVID SUI³

¹University of Florida, IFAS, Hendry County Cooperative Extension Service, P.O. Box 68,
LaBelle, FL 33975

²University of Florida, IFAS, Everglades Research and Education Center, 3200 E. Palm Beach Road,
Belle Glade, FL 33430

³Colorado State University, La Plata County Cooperative Extension, 2500 Main Avenue,
Durango, CO 81301

⁴University of Florida, IFAS, Palm Beach County Cooperative Extension Service, 559 N. Military
Trail, West Palm Beach, FL 33415-1395

ADDITIONAL INDEX WORDS. *Capsicum annuum*, cultivar trial, disease resistance

Cultivars and experimental hybrids of bell peppers (*Capsicum annuum* L.) were transplanted in commercial pepper fields over two growing seasons in several locations in southern Florida to evaluate horticultural characteristics and resistance to bacterial spot of peppers caused by *Xanthomonas euvesicatoria* (formerly *Xanthomonas axonopodis* pv. *vesicatoria* and *Xanthomonas campestris* pv. *vesicatoria*). Cultivars tested included standard commercial varieties with race 1,2,3 bacterial spot resistance as well as newer cultivars and lines that incorporated additional resistance to bacterial spot races 4 and 5. Marketable yield varied widely but little significant difference was detected between cultivars. A number of entries had an overall pepper disease ratings >20% but were statistically similar in marketable yields as the top producing entries. In seasons with high infection rates in the field, resistance to bacterial spot tended to be correlated with yield and quality measurements. The most resistant lines with disease ratings of <3% were '7558', '7141', and '8302' from Seminis and 'Revolution' from Harris Moran.

Bell pepper (*Capsicum annuum* L.) is one of the primary vegetable crops grown in southern Florida, with approximately 90% of Florida's production located south of Orlando (Aerts et al., 2006a). Florida has also historically been a leader in the production of bell peppers, second only to California in total harvested acres (Aerts et al., 2006b) and first in fresh market production with a value of \$267 million during the 2007–08 season (USDA National Agricultural Statistics Service, 2009). During that season 20.2 million bushels were harvested from 18,300 acres, with an average price per bushel of \$10.78.

Bacterial spot (*Xanthomonas euvesicatoria*) is one of the serious diseases facing Florida pepper growers Florida (Pernezny et al., 2008). Loss in yield due to bacterial spot can be attributed to both defoliation and spotting or rotting of fruit.

Ten races of *X. euvesicatoria* have been identified worldwide. A race (identified by numbers—1, 2, 3, etc.) is defined by how well it can survive and grow on cultivars with or without specific genes for resistance. Over the years, genes resistant to various races of *X. euvesicatoria* have been identified and introduced into commercial bell pepper cultivars.

Following the 1989–90 winter vegetable season in southern Florida, when private seed enterprises released horticulturally desirable cultivars with the Bs1 gene, a shift in the prevalent race from race 2 to race 1 occurred in southern Florida. The race-1 strains defeated the Bs1 gene. As a result, major losses occurred in Florida bell pepper fields among cultivars with and without the Bs1 gene. Following this, several seed companies released

cultivars with the Bs2 gene, which confers resistance to races 1, 2, and 3 of *X. euvesicatoria*. Within a few years, commercial growers were planting a range of bell pepper cultivars available to growers having the Bs2 gene, expressing resistance to races 1, 2, and 3 of *X. euvesicatoria*.

In the 1997–98 season in southern Florida, the inevitable happened and field surveys identified races 4 and 6 as the dominant races in fields tested. As a result, serious losses occurred throughout the bell pepper industry in Florida that year. By 2005 commercial seed companies began to release cultivars that were resistant to races 1, 2, 3, 4, and 5 of *X. euvesicatoria* as well as cultivars with resistance to bacterial spot races 1, 2, 3, 4 or 1, 2, 3, 5.

Materials and Methods

Several trials (5) were conducted on growers' farms in various locations in southern Florida, including Delray Beach, Palm Beach County, Naples and Immokalee in Collier County, and Devils Garden in Hendry County during the 2006–07 and 2007–08 fall and spring growing seasons. Transplants were started from seed by a commercial transplant producer using commercial potting mix and polystyrene trays.

Cultivars tested included standard commercial varieties with races 1, 2, and 3 bacterial spot resistance as well as newer cultivars and lines that include additional resistance to bacterial spot races 4 and 5. Seedlings were transplanted by hand, with dead or dying transplants replaced within 10 d of transplanting. Green pepper entries in each location were situated in a randomized complete-block design with three replications for evaluation of mature green peppers.

*Corresponding author; email: gmcavoy@ufl.edu; phone: (863) 674-4092

An additional single replication was used for evaluation of plant architecture and ripe red or yellow pepper yield. This replication was not included in the statistical analysis. Blocks were standard 5-ft-wide, single raised beds on 6-ft centers. Beds were fumigated with methyl bromide/chloropicrin prior to being covered with polyethylene. Each plot consisted of 10 plants planted in double rows, with in-row plant spacing at 8 inches and between-row spacing at 16 inches. Seedlings were planted in an offset, staggered planting design.

The first experiment was conducted in Delray Beach; seeds were sown on 23 Aug. 2006 and transplanted into the field on 10 Oct. 2006. All of the cultivars are marketed as having resistance to at least bacterial spot races 1, 2, 3 and included several that had resistance to races 1, 2, 3, 4; races 1, 2, 3, 5; or races 1, 2, 3, 4, 5 (see Table 1 for descriptions) The soil type was a Myakka sand. After transplant, fertilization, pest management, and all other cultural practices were managed by the growers (Thomas Produce). Plants were staked and tied twice. The first harvest was 65 d after transplant (DAT) on 12 Dec. 2006, with a second harvest on 4 Jan. 2007 (88 DAT).

Seeds for the second experiment in Naples were sown on 25 Sept. 2006 and transplanted into the field on 14 Nov. 2006 using the same varieties planted in trial 1. Varieties were the same as used in the Boca Raton experiment. The soil type was an Immokalee fine sand. Similar to the Boca Raton experiment, the trial was managed by the growers (Six L's) after transplant. Plants

were also staked and tied twice. The first harvest was on 11 Feb. 2007 (88 DAT) with subsequent harvest on 25 Feb. 2007 (102 DAT) and 11 Mar. 2007 (116 DAT).

The third experiment was conducted in Delray Beach; 26 varieties resistant to bacterial spot were planted and replicated four times. Peppers were transplanted into the field on 21 Nov. 2007. First harvest occurred on 30 Jan. 2008. A bacterial spot rating was also made on this date. All of the cultivars are marketed as having resistance to at least bacterial spot races 1, 2, and 3 and included several that had resistance to races 1, 2, 3, 4; races 1, 2, 3, 5; or races 1, 2, 3, 4, 5. The soil type was Myakka sand. After transplant, fertilization, pest management, and all other cultural practices were managed by the growers (Thomas Produce). Plants were staked and tied twice. The first light harvest occurred on 30 Jan. 2008 (71 DAT), with a second harvest on 6 Mar. 2008 (105 DAT).

The fourth experiment was conducted in Devils Garden; 26 varieties resistant to bacterial spot were planted and replicated four times. Peppers were transplanted into the field on 24 Jan. 2008. First harvest occurred on 14 Apr. 2008 (75 DAT). All of the cultivars are marketed as having resistance to at least bacterial spot races 1, 2, and 3 and included several that had resistance to races 1, 2, 3, and 4; races 1, 2, 3, and 5; or races 1, 2, 3, 4, and 5. The soil type was Immokalee Fine sand. After transplant, fertilization, pest management, and all other cultural practices were managed by the growers (Thomas Produce). Plants were staked and tied

Table 1. Fruit yield and fruit characteristics as influenced by bell pepper cultivar, Thomas Produce, Delray Beach, Fla., 2006–07.^z

Cultivar	Avg no.	Wt marketable	Marketable	L × W	Ratio ^y	No. of lobes (%)		Wall thickness	Disease rating ^x
	marketable	fruit	fruit			L: W	3		
	fruit/10 plants	(kg/10 plants)	(Kg/ha)	(cm)				(mm)	(%)
8302	32.67	8.93	32180	9.23 × 10.31	0.9	39.63	55.7	7.35	0.0 l
7141	30.33	8.4	30270	10.02 × 10.18	0.99	45.87	45.82	6.6	0.0 l
Revolution	31	8.15	29369	9.35 × 10.22	0.91	58.03	39.28	7.05	19.5 ij
Aristotle	31.33	7.99	28792	9.42 × 9.79	0.97	60.94	51.15	7.05	12.0 jk
Monarcha 30	30.33	8.4	28288	10.02 × 10.18	0.99	45.87	45.82	6.6	0.0 l
XPP2034	28.33	7.78	28036	8.87 × 9.99	0.89	21.19	64.2	7.85	22.5 h–j
XPP2025	30	7.38	26594	9.30 × 9.12	1.02	49.81	45.73	7.6	31.5 e–h
PR05I-25x26	24.67	7.27	26198	8.76 × 10.00	0.88	28.97	60.87	8.65	11.2 j–l
E418851	26.67	6.96	25081	9.42 × 9.86	0.95	31.28	51.43	7.4	43.2 b–e
5776	25	6.94	25009	9.07 × 10.03	0.9	29.29	54.55	8.05	10.8 j–l
ACR 264	27.67	6.92	24937	9.00 × 9.49	0.95	18.26	69.46	7.8	16.0 ij
XPP1103	26.67	6.91	24900	9.04 × 9.79	0.92	35.28	62.87	6.95	27.5 f–i
ACR 266	27.67	6.74	24288	9.84 × 9.27	1.06	58.3	38.44	7.55	40.0 c–e
Monarcha 24	26	6.41	23099	9.23 × 9.22	1	53.41	44.21	8.2	34.5 e–g
ACX 248	23.67	6.27	22594	9.36 × 9.81	0.95	42.73	51.56	7.7	41.2 c–e
Telstar	24.67	6.22	22414	9.36 × 9.42	1	27.57	61.9	7.65	39.5 c–e
Mahi	21.33	5.94	21405	9.44 × 10.00	0.94	23.2	57.3	7.05	48.2 a–d
Brigadier	20.33	5.94	21405	9.11 × 10.61	0.86	20.61	62.32	5.95	26.2 g–i
Legionnaire	24.33	5.74	20684	9.42 × 9.28	1.01	53.03	42.18	6.7	38.8 c–f
PR05I-23x24	22	5.59	20144	8.84 × 9.55	0.93	42.64	50.69	6.8	61.2 a
PR05T-35x36	21.67	5.2	18738	9.59 × 9.17	1.05	45.88	51.07	7.6	41.2 c–e
Snapper	18	5.05	18198	9.40 × 10.01	0.94	28.27	54.7	7.35	37.0 d–g
Monarcha 26	20.67	5.03	18125	9.42 × 9.42	1	41.26	54.45	7.1	49.5 a–c
Crusader	18.33	4.79	17261	9.26 × 10.06	0.92	32.73	54.84	6.9	48.8 a–d
HM2641	19	4.66	16793	9.02 × 9.42	0.96	25	70.83	6.85	3.2 kl
ACR 284	16.33	3.69	13297	8.83 × 9.39	0.94	45.23	49.06	7.2	53.8 ab
LSD	7.39	1.85			0.06				

^zMean separation in columns by Duncan's multiple range test, 5% level, when applicable.

^yLength to width ratio. Scale: 1.00 = blocky, length same as width.

^xEvaluated and rated 4 Feb. 2007 visual rating of percent loss of photosynthetic material.

twice. Disease rating was performed on 31 Mar. 2008.

At each harvest from all locations, fruit considered mature green or turning (red or yellow) were harvested by hand from the entire plot. Fruit from each plot were placed in paper bags and transported back to refrigerated storage at the University of Florida Everglades Research and Education Center where they were held until yield and quality measurements were made. Number of marketable fruit, weight, and number of lobes was recorded. Number of culls was also recorded, but weight of culls was not taken. Ten randomly selected fruit were taken from each plot and measured for length and width to evaluate blockiness. Data were expressed as an average length and width ratio per fruit.

Bacterial spot ratings were performed in Delray Beach on 4 Feb. 2007 and in Naples on 11 Mar 2007. In 2008, bacterial spot ratings were performed in Delray Beach on 30 Jan. and 6 Mar. and in Devil's Garden on 30 Mar. Ratings are defined as "an estimate of the percentage of symptomatic foliar tissue and leaf surface lost due to disease-induced abscission combined into one number representing loss of photosynthetically active foliage" (Pernezny, personal communication).

Results and Discussion

DELRAY BEACH, THOMAS PRODUCE, 2006–07. Due to rainy weather in Dec. 2006, bacterial spot pressure was extremely high in this trial with some cultivars showing over 50% infection at the time of rating.

Entries in Table 1 are listed in order according to yield of mature green fruit. Fruits from pepper plants were harvested two times over a period of 23 d. It would have been possible to make an additional harvests of fruit and the additional harvest would have contributed to the overall yield. During the late fall and early winter months, the highest yielding entry was '8302' with an average yield of 32,180 lb/acre, followed by '7141' with an average yield of 30,270 lb/acre. Although yields varied widely by greater than 17,000 lb/acre, there was much statistical variation and little statistical significance was detected in the yield per plant. While total yield is an extremely important consideration, it is not the only one for choosing pepper cultivars or varieties. Plant architecture, as indicated by fruit placement and set, and fruit size, as indicated by fruit weight, and blockiness (ratio length : width) are also important variables to consider.

Bacterial spot disease rating varied widely, ranging from 0.01% to 49.9%. Differences were statistically significant and varieties with 1, 2, 3, 4 and 1, 2, 3, 4, 5 resistance showed significantly lower disease ratings. Later analysis of races present in the field showed that over 85% of samples were bacterial spot race 4 (Ken Pernezny, personal communication).

In general, the varieties that had the lowest incidence of bacterial spot infection tended to produce the highest yields with two highest yielding varieties 8302 and 7141 having a 1.1% infection rating. This did not hold true for all varieties. For example, cv. Aristotle with 1, 2, 3 resistance produced good yields despite an disease rating of 12.0%. This may be due to its robust growth

Table 2. Fruit yield and fruit characteristics as influenced by bell pepper cultivar, Six L's, Naples, FL, 2006–07.^z

Cultivar	Avg no. marketable fruit	Wt marketable fruit (kg)	Marketable fruit (Kg/ha)	L × W (cm)	Ratio ^y L:W	No. of lobes (%)		Wall thickness ^x (mm)
						3	4	
E418851	53.00 ab	12.397 a	44674	9.45 × 8.83	0.933	15.95	71.26	6.43
XPP2025	54.00 a	12.343 a	44479	9.30 × 8.65	0.933	49.09	39.44	7.2
Snapper	47.67 a-c	11.697 ab	42151	9.69 × 9.04	0.933	36.82	47.41	6.7
Mahi	52.00 ab	11.507 ab	41467	9.36 × 8.60	0.92	27.35	66.29	6.7
Monarcha 26	49.67 a-c	11.367 ab	40962	9.37 × 8.76	0.937	42.25	44.95	6.9
Revolution	48.67 a-c	11.180 a-c	40288	8.86 × 9.39	1.06	33.63	62.9	6.17
5776	43.33 a-d	10.780 a-d	38847	9.24 × 9.31	1.01	44.68	51.91	7.63
Legionnaire	49.67 a-c	10.710 a-d	38595	9.50 × 8.65	0.913	53.23	66.22	6.83
HM2641	52.00 ab	10.640 a-d	38342	8.64 × 8.54	0.993	17.72	73.76	6.5
Crusader	47.67 a-c	10.497 a-d	37827	8.58 × 9.51	1.11	31.46	60.9	6
PR05I-25x26	45.33 a-d	10.473 a-d	37741	8.53 × 9.21	1.083	31.51	61.46	6.57
PR05I-23x24	47.33 a-c	10.343 a-d	37272	8.92 × 8.81	0.993	38.77	52.35	6.83
Aristotle	46.00 a-d	10.273 a-d	37020	9.15 × 8.71	0.95	64.47	31.79	7
Monarcha 30	45.67 a-d	10.213 a-d	36804	9.37 × 8.53	0.91	36.35	55.55	6.93
XPP2034	47.33 a-c	10.173 a-d	36660	8.70 × 9.23	1.063	46.15	49.46	6.87
ACR 266	45.67 a-d	10.043 a-d	36191	9.48 × 8.42	0.89	56.86	38.93	7.5
XPP1103	45.67 a-d	9.720 b-d	35027	8.78 × 8.70	0.997	54.92	48.84	6.3
ACX 248	40.00 c-e	9.620 b-d	34667	9.39 × 8.81	0.94	28.51	65.62	6.7
Telstar	44.33 a-d	9.523 b-d	34317	8.88 × 8.53	0.963	28.9	63.65	7
Brigadier	40.00 c-e	9.513 b-d	34281	8.84 × 9.26	1.05	32.94	58.1	6.4
ACR 284	45.67 a-d	9.270 b-e	33406	8.30 × 8.57	1.033	22.05	64.98	6.83
PR05T-35x36	40.67 c-e	8.707 c-e	31377	8.81 × 8.63	0.983	33.84	48.23	6.53
7141	38.67 c-e	8.570 de	30883	9.05 × 8.89	0.983	29.73	66.45	6.43
Monarcha 24	42.00 b-e	8.430 de	30378	9.32 × 8.24	0.887	52.13	45.94	7.81
8302	35.67 de	8.400 de	30270	8.56 × 9.24	1.083	35.57	56.37	7
ACR 264	31.33 e	6.823 e	24587	8.91 × 8.75	0.98	26.89	64.71	6.83
LSD	11.07	2.5708			0.060	16.60	20.05	

^zMean separation in columns by Duncan's multiple range test, 5% level, when applicable.

^yLength to width ratio. Scale: 1.00 = blocky, length same as width.

^xEvaluated and rated 4 Feb. 2007 visual rating of percent loss of photosynthetic material.

that enables it to outgrow infections to some extent, which may be why growers have adopted it so widely.

Another trait deemed important and desirable by the pepper industry is blocky or slightly elongated fruit. Some of the resistant cultivars, such as '8302', '5767', and 'Revolution', had low ratios of around 90.

This indicates a relatively compressed fruit, which is not desired by produce brokers. An ideal ratio of fruit length to width would be roughly between 1.00 and 1.20, a range found in most commercially acceptable varieties. Pepper fruit should also have between three and four lobes, with the preference toward four lobes and distinct indentations at the blossom end. Fruit with two lobes tend to be pointed with little indentations and may or may not be saleable, depending on the market. Five-lobed fruit also tend to lose lobe distinction and although they are usually saleable, they are desired less by the industry and the public.

NAPLES, SIX L'S, 2006-07. Similar to Experiment 1, entries in the Naples experiment are listed in order according to yield of mature green fruit (Table 2). Compared to trials in Boca Raton, the Naples experiment took more days to mature from transplant to first harvest. In Naples, the first harvest was 88 DAT, compared to 65 DAT in Delray Beach. Pepper fruit from the Delray Beach experiment was also harvested three times over a period of 38 d. The third harvest was primarily colored fruit and probably could not have been harvested an additional time. The difference in DAT and harvest period between the two locations clearly indicates the

variation between growing seasons and locations. In Boca Raton, temperatures were warmer and days longer during the experiment. In contrast, the Naples experiment was primarily conducted during the winter months when temperatures were lower and day length shorter. This resulted in a longer amount of time to first harvest (heavier initial harvest) as well as longer time between the first and last harvests. These distinctions are important to growers and the allied industry in that certain cultivars or varieties may be best suited to fit into these market windows.

Due to extremely dry weather during the growth of this crop no bacterial spot was detected.

Despite a more than 20,000 lb/acre variation in yield among the entries, substantial statistical differences in yield were not found. Yields were higher in the spring with highest yields showing a 10,000 lb/acre increase over the fall crop. Some differences were seen between entries in number of lobes and blockiness, although many entries had a ratio of length to width less than 1.00, indicating that the majority of the fruit sampled were somewhat flattened in shape.

The varieties that produced the most fruit were different than those that produced the highest yields in the fall in Delray and included only a few with advanced bacterial spot resistance. This could indicate seasonal differences or indicate that in the absence of disease pressure resistant varieties are less productive than other available cultivars.

DELRAY BEACH, THOMAS PRODUCE, 2007-08. Conditions were

Table 3. Fruit yield and fruit characteristics as influenced by bell pepper cultivar, Delray Beach, FL, Winter 2007-08.^z

Cultivar	Seed source	Avg no. marketable fruit/10 plants	Wt marketable fruit/10 plants (kg)	Ratio ^y L:W	No. of lobes (%)		Wall thickness (mm)	Disease rating ^y	
					3	4		30 Jan.	6 Mar.
8302 (grower)	Seminis	37.67 a	8.58 a	0.960	40.73	54.84	6.3	1.5 hg	23.8 g-i
8302	Seminis	35.33 a-c	8.31 ab	0.950	37.00	58.54	5.6	1.25 gh	25.8 gh
Revolution	Harris Moran	37.00 ab	8.18 a-c	0.883	39.44	54.18	6.5	14.00 d-f	50.0 b-e
RPP20719	Rogers/Syn	34.67 a-e	8.16 a-c	0.890	54.68	40.42	6.3	0.75 h	34.5 fg
7141	Seminis	34.67 a-e	8.09 a-d	0.837	41.60	55.69	6.4	0.00 h	11.5 h-j
7588	Seminis	33.33 a-f	7.85 a-e	0.880	30.90	65.16	6.7	0.00 h	25.8 gh
Gold Crown	Sakata	33.33 a-f	7.73 a-f	0.917	42.58	52.20	6.7	25.25 bc	52.5 a-e
ACX 265	Abbott & Cobb	35.00 a-d	7.22 a-g	0.867	35.96	55.33	6.5	20.00 b-e	46.5 d-g
20530-1	Rogers/Syn	29.33 b-f	6.91 b-h	0.953	42.02	56.96	6.8	3.00 gh	19.5 ij
Snapper	Enza	30.67 a-f	6.72 b-i	0.927	22.69	58.43	6.2	15.50 d-f	49.3 b-f
Cardinal	Hazera	30.33 a-f	6.66 c-i	0.913	19.78	66.00	6.8	16.50 c-f	46.3 d-f
5776	Seminis	30.00 a-f	6.66 c-i	0.893	43.40	52.68	7.8	0.50 h	16.5 h-j
PR-04T-13x14R	Pepper Research	28.67 c-f	6.64 c-i	0.843	46.46	48.16	6.6	2.25 gh	3.5 j
Aristotle	Seminis	27.00 ef	6.56 c-i	0.877	55.93	39.27	7.0	9.50 f-h	46.3 d-f
41-0685	Enza	30.33 a-f	6.56 c-i	0.927	33.49	56.45	6.6	2.25 gh	35.0 fg
PR-04T-21x22Y	Pepper Research	29.33 b-f	6.50 d-i	0.867	38.56	51.75	6.7	1.25 gh	10.5 ij
HM2641	Harris Moran	32.33 a-f	6.42 e-i	0.890	30.97	59.20	5.9	1.25 gh	21.5 hi
Red Bull	Sakata	31.00 a-f	6.33 e-i	0.877	49.64	42.85	7.3	36.25 a	55.3 a-e
Crusader	Rogers/Syn	29.67 b-f	6.30 e-i	0.947	29.50	64.05	5.8	28.00 ab	56.3 a-d
XPP2034	Sakata	27.00 ef	6.22 e-i	0.913	35.52	52.34	6.8	22.50 b-d	41.3 ef
Excursion II	Abbott & Cobb	28.33 c-f	6.18 f-i	0.803	55.62	40.76	6.7	21.75 b-d	51.3 b-e
Sargon	Hazera	30.33 a-f	6.16 f-i	0.817	35.30	59.62	7.4	17.50 c-f	55.8 a-e
RPP20809	Rogers/Syn	26.67 f	5.98 g-i	0.900	34.34	58.37	7.1	0.75 h	61.5 a-c
ACX 283B	Abbott & Cobb	27.33 d-f	5.67 g-i	0.887	48.72	42.65	6.9	37.50 a	67.0 a
Telestar	Hazera	25.67 f	5.50 hi	0.870	37.25	54.96	6.3	10.75 e-g	48.8 c-f
PR-05C-67x68R	Pepper Research	27.33 d-f	5.39 hi	0.803	45.15	53.66	6.6	2.25 gh	14.3 h-j
ACX 266	Abbott & Cobb	25.67 f	5.28 i	0.790	41.06	52.77	6.2	35.75 a	63.8 ab

^zSeeded. Transplanted on 21 Nov. 2007. Average of 3 replications and 1 harvest date. Twelve plants per plot, planted in double row on standard pepper bed (17,500 plants per acre).

^yDisease rating is a percentage of plot showing foliar bacterial spot lesions. Plants were rated on 30 Jan. 2008.

Table 4. Fruit yield and fruit characteristics as influenced by bell pepper cultivar, Thomas Farms, Devils Garden, FL, Winter 2008.^z

Cultivar	Avg no.	Wt	L × W (cm)	Ratio ^y L: W	No. of lobes (%)		Wall thickness ^x (mm)	Disease rating (%)
	marketable fruit	marketable fruit/plant (kg)			3	4		
Revolution	28.7 bc	14.62 a	9.89 × 10.36	0.955	33.7	53.5	6.1	15.0 f-h
8302	42.0 a	11.38 ab	9.63 × 10.57	0.911	24.6	60.3	5.9	0.5 j
7588	30.3 b	9.98 a-c	10.03 × 9.70	1.034	24.2	61.5	6	2.25 j
Aristotle	29.7 b	8.94 b-d	9.89 × 9.90	0.999	37.1	56.2	6.4	21.5 e-g
PR-04T-21x22Y	28.7 bc	8.62 b-d	10.17 × 9.45	1.076	27.9	57	6.6	4.0 j
RPP20809	26.0 b-d	8.57 b-d	10.02 × 9.68	1.035	26.1	61.4	5.5	14.0 f-i
20530-1	29.3 bc	8.21 b-d	9.57 × 9.53	1.004	38.6	56.8	6.5	1.5 j
RPP20719	28.7 bc	7.76 b-e	9.22 × 9.52	0.968	46	50.6	6.2	0.5 j
7141	28.7 bc	7.08 b-e	10.28 × 9.95	1.033	28.7	59.8	5.6	0.75 j
Red Bull	25.3 b-d	7.03 b-e	10.32 × 9.63	1.072	56.6	36.8	6.7	21.8 d-g
Cardinal	21.7 b-e	6.8 b-e	10.48 × 10.30	1.017	23.1	56.9	6	22.3 d-f
Telestar	24.7 b-d	6.8 b-e	9.80 × 9.75	1.005	25.7	60.8	5.7	13.8 g-i
41-0685	23.0 b-d	6.8 b-e	9.43 × 10.50	0.898	17.4	65.2	6.8	7.3 h-j
Excursion II	24 b-d	6.58 c-e	9.88 × 9.35	1.057	44.4	48.6	6.2	42.0 a
XPP2034	21.0 b-e	6.53 c-e	9.82 × 9.97	0.985	22.2	69.8	6.4	24.0 c-e
5776	20.7 b-e	6.21 c-e	10.08 × 10.20	0.988	21	62.9	5.9	3.0 j
ACX 283B	20.8 b-e	6.21 c-e	9.94 × 10.04	0.99	22	67.8	7	30.0 b-d
PR-05C-67x68R	22.3 b-e	5.81 c-e	10.13 × 9.07	1.117	27	54	7.1	6.0 ij
Crusader	14.7 de	5.26 c-e	9.65 × 10.22	0.944	16.7	63	5.7	28.0 b-e
Gold Crown	17.0 de	5.26 c-e	9.60 × 10.17	0.944	29.9	62.8	5.9	23.5 de
ACX 266	18.0 c-e	5.31 c-e	10.62 × 9.30	1.142	32.5	61.1	6	29.3 b-e
ACX 265	18.0 c-e	4.85 de	10.02 × 9.03	1.077	37.7	52.8	5.5	25.3 b-e
Crusader	15.0 de	4.85 de	9.03 × 10.32	0.875	8.9	73.3	5.7	27.6 b-e
Sargon	16.3 de	4.81 de	10.07 × 9.38	1.074	38.8	51	7.1	32.8 b
Snapper	15.7 de	4.58 de	9.90 × 10.13	0.977	21.3	72.3	6.2	32.0 bc
PR-04T-13x14R	19.0 b-e	4.45 de	9.18 × 9.07	1.012	54.6	38.2	6.5	1.75 j
HM2641	11.3 e	3.31 e	8.81 × 9.77	0.781	14.7	67.6	6.5	6.8 h-j

^zTransplanted on 7 Jan. 2008. Average of 3 replications and 1 harvest date. Twelve plants per plot, planted in double row on standard pepper bed (17,500 plants per acre).

^yDisease rating is a percentage of plot showing foliar bacterial spot lesions. Plants rated on 31 Mar. and harvested on 14 Apr. 2008

relatively dry during early part of this trial and bacterial spot pressure was low and, consequently, the first bacterial spot ratings were relatively low but differences between cultivars were statistically significant, with most of the cultivars with advanced levels of resistance exhibiting less than 3% infection while race 1, 2, and 3 entries had up to 20% infection. Following unusual late season rains in late Dec. 2007 and Jan. 2008, bacterial spot took off and the second rating had a rating that ranged between 3.5% and 63.8% with the majority of cultivars, including the 1, 2, 3, 4 and 1, 2, 3, 4, 5, entries rated above 20% infection. Initially, this was puzzling, but subsequent analysis of bacteria samples revealed the presence of race 6 bacterial spot in the field.

Entries in Table 3 are listed in order according to yield of mature green fruit. Fruits from pepper plants were harvested two times over a period of 34 d. It would have been possible to make an additional harvest of fruit, and the additional harvest would have contributed to the overall yield. The highest yielding entry was '8302', followed by 'Revolution'. Although yields varied widely there was much statistical variation and little statistical significance was detected in the yield per plant.

As expected and as noted in the 2007–08 experiments, under high bacterial spot pressure those varieties with the lowest bacterial spot rating tended produce the highest yields but this was not consistent.

DEVILS GARDEN, THOMAS PRODUCE, 2007–08. Due to rainy weather in Mar. 2008, bacterial spot pressure was extremely high

in this trial, with some cultivars displaying up to 50% infection at the time of rating.

Entries in Table 4 are listed in order according to yield of mature green fruit. Fruits from pepper plants were harvested one time on 14 Apr. and again on 28 Apr. It would have been possible to make an additional harvest of fruit and the additional harvest would have contributed to the overall yield, but the grower decided to halt production due to poor market conditions.

The highest yielding entry was 'Revolution', followed by '8302' and '7588'. Although yields varied widely, there was much statistical variation and little statistical significance was detected in the yield per plant. As expected and as noted in previous experiments, under high bacterial spot pressure those varieties with the lowest bacterial spot rating tended to produce the highest yields, but this was not consistent.

Cultivars with advanced levels of bacterial spot resistance tended to produce higher yields under conditions of severe bacterial spot pressure. However low resistance to bacterial spot did not necessarily correlate to decreases in yield and horticultural quality with some entries producing good yields despite having relatively high bacterial spot ratings. Conversely, some entries that had an elevated incidence of bacterial spot did show below-average yields. Further research is needed to determine if a correlation between lower yield and bacterial spot exists for these entries.

Performance differences were noted depending on season with some varieties tending to do better in the fall or spring.

While total yield is an extremely important consideration, it is not the only one for choosing pepper cultivars or varieties. Plant architecture, as indicated by fruit placement and set, and fruit size, as indicated by fruit weight, and blockiness (ratio L:W) are also important variables to consider.

Use of cultivars with of bacterial spot resistance to races 1–5 did significantly reduce overall bacterial spot ratings and may provide growers with a tool to make a crop with reduced input costs under high bacterial spot pressure. Future breeding efforts may make these varieties more reliable and or combine these resistance traits with superior horticultural characteristics.

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