한국식물병리학회지 14(3) : 217-219(1998)
Korean J. Plant Pathol. 14(3) : 217-219(1998)

Resistance to Bacterial Wilt of Introduced Peppers

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고추 도입계통의 풋마름병 저항성

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ABSTRACT: Of over 100 accessions of pepper tested, MC 4 and MC 5, PBC631, PI322727, PI358812, PBC066, Kerting, PI322726, PI369994, PI369998, PI377688, CMS-B, PI322728, and Jatilaba showed similarly high level of resistance to bacterial wilt (*Ralstonia solanacearum*).

***Key words*: *Capsicum annuum*, resistance, breeding, *Ralstonia solanacearum*.**

In 1994, we tested the Phytophthora resistant breeding lines pepper (6) for adaptability in a local condition. The hope was that these breeding lines would be adaptable for use in Subi, Youngyang in Kyungpook province. During the experiment we found that the local cultivar, Subi and the breeding lines were severely infected by bacterial wilt. It was therefore necessary to increase the wilt resistance of these Phytophthora resistant lines.

Sporadic bacterial wilt on Korean peppers is caused by *Ralstonia solanacearum* (Smith) Yubuuchi *et al.* Because the pathogen causes an internal stem infection, chemical control of the disease is ineffective. Crop rotation might be effective, but it is not favoured by farmers in the absence of an alternative cash crop. The breeding of resistant cultivars is therefore desirable for the control of the disease.

Resistance to bacterial wilt was found in Indian hot peppers by Peter *et al.* (12), in MC 4 and MC 5 by Matos *et al.* (8), and in a few PI lines by Lim and Kim (7). In this study we tested more than 100 accessions of pepper for bacterial wilt resistance, including MC 4 and MC 5.

MATERIALS AND METHODS

Germplasm. MC 4 and MC 5 were received from Lopes in Brazil; PBC631, PBC066 and C00505 were received from Poulos in Taiwan. These accessions are known to be resistant to bacterial wilt. In our study we tested more than 100 accessions of pepper for bacterial wilt resistance, including MC 4 and MC 5.

Preliminary evaluation. Thirty nine lines were sown in July, 1995 and evaluated for resistance to bacterial wilt. The lines included MC 4, MC 5, PBC631, PBC 066, C00505, Phytophthora resistant breeding lines (6) and PI lines that were resistant in a previous study (7). Ninety one accessions, including the resistant introductions, were sown on August 31, 1995, and evaluated for resistance. Seeds were sown in trays filled with "Barokur" mix (Seoul-Agro-Materials Co.). Seedlings were removed from the soil at the 4~5 leaf stage. The root systems were washed in tap water and dipped in a bacterial cell suspension for inoculation. The inoculated seedlings were planted in plastic trays with 32 holes of 5 cm in diameter and 6 cm in depth. (Samjung Industry) Again "Barokur" mix was used. Sixteen plants per line were included in all the experiments including previous and following tests. The inoculum was prepared by washing the 48-hour culture of the pathogen on TTC (13) plates. The cell concentration of the suspension was adjusted to approximately 10^8 cells/m*l*. The turbidity was measured using McFarland turbidity tubes (4). Twenty six promising lines from the two preliminary evaluation sets were sown on July 30, 1996, and evaluated again. This time, before the bacterial inoculation, the root systems of the seedlings were severed at a point 1/3 from the root tip. The inoculated plants were then transplanted to the plastic trays, following the method of the previous evaluation.

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Disease was rated in all three tests on a scale of 1 to 5, where: 1=no visible symptoms; 2=one to less than half of the leaves drooping; 3=about half of the leaves wilting; 4=nearly all of the leaves wilting; 5=the whole plant wilting or dead.

Confirmative evaluation. Thirty two accessions including the resistant selections from the 1995/6 tests, along with a control group of susceptible local cultivars were sown on July 30, 1997. On August 30, 1997, the seedlings were inoculated by dipping the roots in the bacterial suspension; the roots were not severed this time. In addition, a bacterium collected in Punggak, Cheongdo in Kyungpook province was employed in the inoculation. This was a fresher, more virulent isolate of the pathogenic bacterium. The experiment was conducted in a greenhouse, and the disease was measured on September 8, 13 and 24, 1997, using the same scale as before.

RESULTS AND DISCUSSION

MC 4, MC 5 and PBC631, the original resistant sources (8, Poulos, personal communication) were resistant to the Korean isolate of the bacterial wilt pathogen in preliminary test. PI377688, PI322726, PI369994, PI 358812 which have been reported resistant (7) and some others were also found to be resistant. However, the Phytophthora resistant breeding lines were found to be highly susceptible, as observed in Youngyang in 1994. In the second evaluation, the disease development was a little hindered due to the low temperatures characteristic of early fall in the region; in the third evalu-

Table 1. Resistance to bacterial wilt of selected lines of pepper after inoculation by dipping the root system in the pathogenic bacterial suspension

KC. No.	Cultivar or original name	No. of plants tested	Mean disease index[z] after inoculation		
			9 days	14 days	25 days
350	MC 4	16	1.06 a[y]	1.06 a[y]	1.19 ab[y]
350-2	MC 4	16	1.06 a	1.06 a	1.19 ab
351	MC 5	16	1.00 a	1.06 a	1.13 ab
353-1	PBC631(CA 8)	16	1.00 a	1.06 a	1.13 ab
353-3	PBC631(CA 8)	16	1.00 a	1.06 a	1.06 ab
122	PI322727	15	1.07 a	1.13 a	1.13 ab
126	PI358812	16	1.06 a	1.13 a	1.06 ab
352	PBC066(MC 4)	15	1.25 a	1.13 a	1.44 abc
353	PBC631(CA 8)	16	1.06 a	1.13 a	1.13 ab
359	Kerting	16	1.00 a	1.13 a	1.13 ab
121	PI322726	16	1.06 a	1.19 a	1.44 abc
127	PI369994	16	1.00 a	1.19 a	1.00 a
131	PI369998	16	1.31 ab	1.38 a	1.44 ab
137	PI377688	16	1.38 abc	1.44 abc	1.44 abc
382	CMS-B	16	1.50 a-d	1.50 a-d	1.56 a-d
123	PI322728	16	1.27 ab	1.69 a-e	1.93 a-e
355	Jatilaba	16	1.88 a-g	1.88 a-f	1.75 a-e
376	Kilnong No. 4	10	1.70 a-e	2.20 b-f	1.80 a-e
357	Indonesian	16	2.13 b-g	2.31 c-g	2.00 b-e
436	Sanyon No. 9	16	1.81 a-f	2.38 d-g	2.19 c-f
354	C00505(Sinagtala)	12	2.08 b-h	2.42 d-g	2.42 d-f
356	Brebes	16	2.31 d-i	2.50 e-h	2.25 c-f
16-2-2-3-2	Kalmi PR	16	2.25 d-i	2.56 e-h	2.38 c-f
Oryun	F_1 hybrid	16	2.38 d-i	2.75 f-i	2.63 e-g
207	Punggak	16	2.44 e-i	3.19 g-j	2.94 fgh
19-2-4-5-3-2	Subi-PR	8	2.50 f-i	3.25 hij	3.25 ghi
365	Korean	16	2.75 ghi	3.38 hij	3.31 ghi
202	Subi	14	3.36 j	3.50 ij	3.00 fgh
201	Chilsung	11	2.91 hij	3.55 ij	3.64 hi
378	*C. pubescens*	16	2.69 f-i	3.56 ij	3.63 hi
441	Jungan	16	3.06 ij	4.06 jk	4.13 i
340	T542	8	2.75 g-i	4.50 k	5.00 j

[z] 1=no symptom; 2=one leaf wilting; 3=about a half of leaves wilting; 4=nearly all the leaves wilting; 5=whole plant wilting or dead.
[y] Mean separation within within columns by Duncan's multiple range test. at $P<0.05$.

ation, the damage caused by severing the root system was too severe. Thus, a confirmative test was conducted in 1997 for self satisfaction, the results of which appear in Table 1.

MC 4, MC 5 and PBC631 appeared to be the most resistant. PI322727, PI358812, PBC066, Kerting, PI 322726, PI369994, PI369998, PI377688, CMS-B, PI 322728 and Jatilaba also showed the same or similar level of resistance. Particularly, a few plants showed wilting in 14th day reading but all recovered in 25th day reading. MC 4 and MC 5 were already reported resistant by Matos *et al.* (8). PBC631 and PBC066 (the Taiwan AVRDC strains) were also considered resistant (J. Poulos, personal communication). Resistance of the PI lines was reported previously by Lim and Kim (7). PI369994, PI369998, and PI377688 are also resistant to bacterial spot caused by *Xanthomonas campestris* pv. *vesicatoria* (5). Consequently, they can be used in breeding for resistance to both diseases. Kerting and Jatilaba are Indonesian peppers and new additions to the bacterial wilt resistant accessions. CMS-B is a maintainer of a cytoplasmically male sterile line. Thus resistance was found in various sources. Matsunaga *et al.* (9-11) also tested various pepper accessions for resistance to bacterial wilt in Japan; they reported that many lines, including LS1439 were resistant to bacterial wilt. Thus, introducing and testing these lines is also worthwhile.

Disease symptoms began to appear 4~5 days after inoculation. Initial symptoms were the drooping of one to all of the leaves on a plant. The level of resistance of plants was tolerant, but not immune. Even in the most resistant strains, one to a few plants showed signs of drooping, or even wilted and died. Some surviving plants occasionally showed stem distortion or black veining on leaves. Bacterial ooze could be seen coming out from black veins when observed under a microscope. When cut for discarding, minor blackening of the vascular system could be seen on some plants with no external visible symptoms. Hence the plants display a tolerant resistance that is associated with the plant's capacity to limit the bacterial colonization in the vascular system. This capacity has also been observed in tomatoes (1-3).

ACKNOWLEDGEMENTS

This research was financially supported by Korea Science and Engineering Foundation (Project No. 961-0601-004-2).

요 약

총 100여점의 고추 계통에 대하여 풋마름병에 대한 저항성을 검정한 결과 MC 4, MC 5, PBC631, PI322727, PI358812, PBC066, Kerting, PI322726, PI369994, PI 369998, PI377688, CMS-B, PI322728, Jatilaba가 비슷한 수준의 높은 저항성을 나타내었다.

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(Received May 22, 1998)