Resistance to Gray Leaf Spot in Capsicum Peppers

H.J. Cho1, B.S. Kim2, and H.S. Hwang1
Department of Horticulture, Kyungpook National University, Taegu 702-701, Korea

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Abstract. Of 467 accessions of Capsicum pepper (Capsicum annuum L.) tested for resistance to gray leaf spot, KC321, KC220, KC208, KC47 (PI244670), KC43 (PI244670), KC380, and KC319 were highly resistant to both Stemphylium solani and S. lycopersici, the causal agents of gray leaf spot.

Materials and Methods

Expt. 1. Preliminary mass screening. Preliminary evaluation for resistance to Stemphylium lycopersici was conducted with three sets of plantings and inoculations. Included were 463 accessions of C. annuum L., two of C. pubescens Luiz & Pavon and one each of C. baccatum L. and C. frutescens L. from the B.S.K.'s collections from all over the world, including 93 U.S. Plant Introduction lines and 107 local Korean cultivars. Seeds were sown in Barokur® mix (Seoul Agricultural Materials Co., Seoul, Korea) in 128-cell trays in the greenhouse (first set), to an outdoor nursery (second set), or to 72-cell trays in the field. The germinated seedlings were transplanted to 32-cell trays filled with Barokur® mix in the greenhouse (first set), to an outdoor nursery (second set), or to 72-cell trays in the greenhouse (third set), where they were maintained until completion of the test. Each accession, 8–12 plants were used in each test. A commercial hybrid ‘Kumtap’ was included as a susceptible control in every set.

An isolate of S. lycopersici collected from Ipseok, Andong, Kyungpook province. For sporulation, both species of Stemphylium were seeded on V8® juice agar plates with three to four mycelial pieces in each plate and cultured at 20 to 25°C and a 12-h photoperiod provided by fluorescent lights. Plastic petri dishes were used instead of the glass ones made in Korea. Both S. solani and S. lycopersici sporulated abundantly. Spores were collected from 3-d-old cultures on the plates and spore suspensions were prepared as in Expt. 1.

Pepper seedlings were inoculated and incubated as in Expt. 1. Disease was scored 16 d after inoculation based on two scales, disease index as in the preliminary mass screening, and the average number of spots formed on the three most diseased leaves of each plant, counted with a mechanical counter. The experiment was conducted on seedlings grown in trays and 6 to 10 plants were tested per accession. Therefore, a completely randomized design was used, considering the individual plants in each line as replications. The SAS GLM and MEANS procedure was used for statistical analysis.

Results and Discussion

Expt. 1. Preliminary mass screening. A total of 101 accessions were tested in the first set, of which eight showed mean disease indices <2.0 (Table 1). No spots were found on KC47 ‘PI244670’, KC174 ‘Early Jalapeno’, or KC380 ‘Habuksung’. Accessions showing resistance in the first set were evaluated in an outdoor nursery in the second set. However, bacterial spot and Phytophthora blight interfered with disease readings and reduced the number of usable plants. The six least-diseased accessions of the 206 tested are listed in Table 1. Two of the best three accessions were among those selected in the first set. In the third set, 13 accessions of the 171 tested showed mean disease indices <2.0, with KC380, KC47...
and KC319, which were included as resistant controls, ranking highest among resistant lines (Table 1).

Expt. 2. Confirmation evaluation for resistance to both *S. solani* and *S. lycopersici*. Twenty accessions selected in preliminary evaluations and three susceptible controls were tested again for resistance to both *S. solani* and *S. lycopersici*. KC320, KC220, KC208, KC47 (PI244670), KC43 (PI241670), KC380, and KC319 were highly resistant to both *S. solani* and *S. lycopersici* (Table 2) as expected, based on results of the preliminary tests. Numerous spots developed on the susceptible controls such as 'Subi', 'Chilsung' and 'Kumtap', causing discoloration and defoliation. Some other accessions were also less affected than the susceptible controls. The resistant accessions, which were initially selected only for resistance to *S. lycopersici*, showed resistance to both *S. solani* and *S. lycopersici*. The phenotypic correlations between both the mean disease indices and the mean numbers of spots formed on the three most diseased leaves for the two Stemphylium species (0.92 and 0.87, respectively) were highly significant. The coefficients of variation for disease index and mean number of spots on a leaf were 21% and 52%, respectively, for inoculation with *S. solani* and 29% and 70%, respectively, for inoculation with *S. lycopersici*. Thus, disease index was the better indicator of resistance. Counting the number of spots on the leaves was time-consuming and tedious. 

PI244670 and PI241670 were resistant to Stemphyllium and have been reported to possess quantitative resistance to bacterial spot (Cook and Sowell, 1963; Kim, 1988; Sowell, 1960). KC14 (PI201234) has resistance to Phytophthora blight (Kim, 1986, 1988; Kimble and Grogen, 1960) and was also moderately resistant to gray leaf spot. All of the resistant lines and the other genotypes used in this study are maintained by the second author and available to interested parties.

Although Weber (1930) reported that *S. solani* sporulated well on potato dextrose agar, we had difficulty in inducing sporulation. However, *S. lycopersici* sporulated abundantly on mycelial blocks when incubated on water agar with CaCO₃ under cool, dark conditions as reported for *Alternaria* species (Sahin and Shepard, 1979). This was the reason why we used *S. lycopersici* in the preliminary evaluations, although *S. solani* is the dominant species in Korea (Cho, 1997). Later, we found that the glass lids of domestically produced petri dishes inhibited sporulation, possibly by blocking transmission of ultraviolet light. Abundant sporulation was obtained when plastic petri dishes were used. We also found that both species were sporulating well on V8 juice agar in Pyrex® glass petri dishes.

Gray leaf spot is an important disease in pepper fields located in mountainous terrain in Korea, and the resistant lines selected will be used in breeding for resistance.

### Table 1. Resistance to *Stemphylium lycopersici* in the top class accessions and in the susceptible control 'Kumtap' in the three sets of plantings.

| KC no. | Cultivar            | No. plants tested | Mean disease index¹ | No. plants tested | Mean disease index¹ | No. plants tested | Mean disease index¹ |
|--------|---------------------|-------------------|---------------------|-------------------|---------------------|-------------------|---------------------|
| 174    | Early Jalapeno      | 10                | 1.0 a              | 12                | 1.1 a               |                   |                     |
| 380    | Habukung            | 10                | 1.0 a              | 12                | 1.1 a               |                   |                     |
| 319    | Unknown             | 10                | 1.2 a              | 8                 | 1.1 a               | 12                | 1.2 ab              |
| 43     | PI241670            | rabbits           | 1.2 a              | 12                | 1.3 a               |                   |                     |
| 158    | Red chili           | rabbits           |                    |                   |                     |                   |                     |
| 120    | Unknown             | rabbits           |                    |                   |                     |                   |                     |
| 318    | Albaregia           | rabbits           |                    |                   |                     |                   |                     |
| 157    | Papi Sweet          | rabbits           |                    |                   |                     |                   |                     |
| 14     | PI201234            | rabbits           | 1.6 b              | 12                | 1.5 a               |                   |                     |
| 220    | Beopjeon            | rabbits           | 1.6 b              | 12                | 1.4 a               |                   |                     |
| 40     | PI241641            | rabbits           |                    |                   |                     |                   |                     |
| 314    | Hungary             | rabbits           | 1.7 b              | 12                | 1.6 a               |                   |                     |
| 208    | Jinaan              | rabbits           |                    |                   |                     |                   |                     |
| 304    | Tam Mild Jalapeno   | rabbits           |                    |                   |                     |                   |                     |
| 312    | Kecskeszvar         | rabbits           | 1.8 b              | 12                | 1.7 a               |                   |                     |
| 52     | PI257047            | rabbits           | 7.8 a              | 12                | 1.6 a               |                   |                     |
| 6      | PI164677            | rabbits           | 6.8 a              | 12                | 1.6 a               |                   |                     |
| 390    | Dochigi-Sandaka     | rabbits           | 8.2 d              | 12                | 1.8 b               |                   |                     |
| 322    | Seodong             | rabbits           | 1.8 d              | 12                | 1.8 b               |                   |                     |
| 305    | Tam Mild Chile       | rabbits           |                    |                   |                     |                   |                     |
| F1 hybrid | Kumtap | rabbits           | 4.9 c              | 4                  | 4.0 b               | 12                | 4.7 e               |

¹= no spots; 2 = 1–3 spots on a leaf; 3 = 4–6 spots; 4 = 7 or more spots developed on a leaf but no yellowing; 5 = 7 or more spots per leaf with yellowing.

### Table 2. Disease ratings for selected lines of pepper after inoculation with *Stemphylium solani* and *S. lycopersici*.

| KC no. | Cultivar       | No. spots per leaf² | Mean disease index² | No. spots per leaf² | Mean disease index² |
|--------|----------------|---------------------|---------------------|---------------------|---------------------|
| 320    | Unknown        | 0.2 a               | 0.0 a               | 1.0 a               |                     |
| 220    | Beopjeon       | 0.4 a               | 0.0 a               | 1.0 a               |                     |
| 208    | Jinacho        | 1.4 a               | 1.0 a               | 1.4 a               |                     |
| 47     | PI244670       | 1.9 a               | 1.2 a               | 2.5 a               | 0.3 a               |
| 43     | PI241670       | 2.4 a               | 1.6 a               | 2.1 ab              | 0.7 a               |
| 380    | Habukung       | 2.4 a               | 1.1 a               | 1.6 a               | 0.7 a               |
| 319    | Unknown        | 7.4 a               | 2.2 bc              | 2.0 ab              | 0.7 a               |
| 390    | Dochigi-Sandaka| 15.8 a–c            | 3.6 de              | 3.9 de              | 0.3 d               |
| 174    | Early Jalapeno  | 16.8 a–c            | 2.5 cd              | 3.6 cd              | 2.7 cd              |
| 195    | Seodong        | 22.7 bc             | 2.6 cd              | 3.6 cd              | 16.5 d              |
| 158    | Red chili      | 24.3 a–d            | 3.3 d               | 4.1 de              | 8.1 a–c             |
| 326    | Kecskeszvar    | 30.0 a–c            | 2.9 e–g             | 4.1 de              | 18.5 cd             |
| 305    | Tam Mild chile  | 31.8 a–c            | 3.6 e–g             | 4.0 de              | 27.3 d              |
| 14     | PI201234       | 31.9 a–c            | 3.9 fg              | 4.0 de              | 21.2 cd             |
| 304    | Tam Mild Jalapeno| 41.0 a–f           | 3.3 d               | 4.0 de              | 7.1 a               |
| 40     | PI241641       | 41.4 a–f            | 3.9 fg              | 4.0 de              | 27.9 d              |
| 6      | PI164677       | 43.4 ef             | 3.3 ab              | 4.0 de              | 28.4 d              |
| 322    | Navator F₁      | 44.7 ef             | 55.7 e              | 4.3 g               |                     |
| 312    | Keckeszvar     | 54.8 fg             | 44.7 e              | 4.3 g               |                     |
| 157    | Papi Sweet     | 62.6 g              | 28.4 d              | 4.0 fg              |                     |
| 202    | Subi           | 86.1 h              | 77.6 f              | 4.5 g               |                     |
| F₁ hybrid | Kumtap     | 96.1 hi             | 56.8 e              | 4.5 g               |                     |
| 201    | Chilsung       | 107.3 i             | 48.4 e              | 4.3 g               |                     |

²Number of spots formed on the three most diseased leaves.

³Disease index of the most diseased leaf on a plant: 1 = no spots; 2 = 1–3 spots; 3 = 4–6 spots; 4 = 7 or more spots developed on a leaf but no yellowing; 5 = 7 or more spots per leaf with yellowing.

³Mean separation within columns by Duncan’s multiple range test, *P* ≤ 0.05.

³Resistant controls.
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