

Characterization of the Anthracnose Resistance in the Differential Cultivar Widusa M.C. Gonçalves-Vidigal¹, Veronica Vallejo² and J.D. Kelly²

¹Departamento de Agronomia, Universidade Estadual de Maringá, Av. Colombo, 5790, 87020-900, Maringá, PR, Brazil

²Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48824, USA

Introduction

Anthracnose caused by *Colletotrichum lindemuthianum* (Sacc. and Magn.) Scrib. is one of the most widespread and economically important fungal diseases of common bean (*Phaseolus vulgaris* L.). Genetic resistance is the most effective method of control of anthracnose in common bean where ten major resistance genes have been characterized. Inheritance of anthracnose resistance in the differential cultivar Widusa has not been fully characterized. To facilitate the use of Widusa as a source of resistance to anthracnose, we investigated its mode of inheritance in a series of allelism tests with previously characterized resistance genes.

Material and Methods

Parental, F₁ and F₂ generations of seven crosses with Widusa shown on Table 1, and susceptible check varieties were grown in the greenhouse. The protocol for inoculation was as follows: 14-day-old bean plants with a fully developed first trifoliolate leaf were spray-inoculated with a spore suspension (1.2×10^6 spores mL⁻¹) of each race of *C. lindemuthianum* (Table 1). After seven days of incubation in a mist chamber, seedlings were evaluated for their disease reaction using a scale of 1 to 9 (Balardin et al. 1990; Pastor-Corrales, 1991). Plants with a disease reaction score of 1-3 were considered resistant, whereas plants that rated 4-9 were considered susceptible.

Results and Discussion

The inheritance studies supported an expected 3:1 ratio of resistant to susceptible individuals in the F₂ population from the R x S cross of Widusa x Michigan Dark Red Kidney (MDRK) inoculated with race 7. These data indicate that Widusa carries a single dominant gene for resistance to race 7. Results of allelism tests in F₂ populations derived from crosses involving Widusa with Cornell 49242 (*Co-2*) (race 7), TO (*Co-4*) (races 7 and 73), TU (*Co-5*) (race 73), and BAT 93 (*Co-9*) (race 7), showed segregation ratios of 15R:1S when populations were inoculated with races that produced a resistant reaction in both parents. This indicates that these F₂ populations showed independent segregation at two loci, where either of the dominant resistance genes in the parents is capable of conferring resistance. In the cross Widusa x PI 207262 (*Co-4*³, *Co-9*), the F₂ segregation ratio was 63R:1S, showing that three independent dominant genes were involved for resistance to race 73. Therefore, according to these results, the anthracnose resistance gene in Widusa is independent of *Co-2*, *Co-4*, *Co-4*³, *Co-5*, and *Co-9* genes. In the cross of Widusa with G 2333 (*Co-4*², *Co-5*, *Co-7*) (race 73), the F₂ segregation ratio was 255R:1S which indicated that four independent dominant genes were segregating for resistance, one from Widusa and the other three from G 2333 (Young et al., 1998). The combined results of these allelism tests support the hypothesis that the gene that confers resistance to anthracnose in Widusa is independent of *Co-2*, *Co-4*, *Co-4*², *Co-4*³, *Co-5*, *Co-7*, and *Co-9* genes. The F₂ population derived from the cross Widusa and MDRK, when inoculated with race 65, showed no segregation among 200 individuals, suggesting that Widusa carries an allele at the *Co-1* locus. Our data are not in agreement with those of Alzate-Marín et al. (2001) who

showed a lack of segregation of Widusa in crosses with PI 207262 whereas we demonstrate clear independence in crosses with PI 207262 and complementary with the resistance allele at the *Co-1* locus in MDRK.

Since Widusa is an Andean differential cultivar (Drijfhout and Davis, 1989), it is not surprising that it carries an allele at the *Co-1* locus. The *Co-1* locus is the only Andean anthracnose resistance locus identified in common bean to date. Previous studies have revealed that *Co-1* is a complex locus with a multi-allelic series where three alleles have been previously identified (Melotto and Kelly, 2000). Since Widusa has a different resistance spectrum from all other characterized *Co-1* alleles based on its position in the differential series, these data would indicate that it carries a new allele at this locus. The authors propose that the anthracnose resistance allele in Widusa be designated *Co-1*⁵ as the *Co-1*⁴ allele was reported in AND 277 (Alzate-Marin et al., 2003).

Table 1. Allelism tests for genetic characterization of anthracnose resistance in Widusa

Population	Race	Reaction*	Resistance Gene	Observed Ratio		Expected ratio	χ^2	P value
				R	S			
Widusa x MDRK	7	R x S	<i>Co-1</i>	164	57	3 : 1	0.074	0.79
Widusa x Cornell 49242	7	R x R	<i>Co-2</i>	137	11	15 : 1	0.353	0.55
Widusa x TO	7	R x R	<i>Co-4</i>	174	12	15 : 1	0.013	0.92
Widusa x BAT 93	7	R x R	<i>Co-9</i>	229	17	15 : 1	0.183	0.67
Widusa x MDRK	65	R x R	<i>Co-1</i>	200	0	---	---	---
Widusa x TO	73	R x R	<i>Co-4</i>	200	11	15 : 1	0.387	0.53
Widusa x TU	73	R x R	<i>Co-5</i>	92	5	15 : 1	0.199	0.66
Widusa x PI 207262	73	R x R	<i>Co-4</i> ¹ , <i>Co-9</i>	352	6	63:1	0.029	0.86
Widusa x G 2333	73	R x R	<i>Co-4</i> ² , <i>Co-5</i> , <i>Co-7</i>	294	1	255 : 1	0.020	0.89

* R = Resistant S = Susceptible; MDRK = Michigan Dark Red Kidney.

Acknowledgement: M.C. Gonçalves-Vidigal is sponsored by CAPES. The author would like to thank Halima Awale for her assistance in these studies.

References

- Alzate-Marin, A.L., de Almeida, K.S., de Barros, E.G., and Moreira, M.A. 2001. Preliminary results of allelism studies for anthracnose resistance genes of common bean cultivar PI 207.262. Ann. Rept. Bean Improv. Coop. 44:113-114.
- Alzate-Marin, A.L., Arruda, K.M., de Barros, E.G., and Moreira, M.A. 2003. Allelism studies for anthracnose resistance genes of common bean cultivar AN 277. Ann. Rept. Bean Improv. Coop. 46: (Current issue).
- Balardin, R.S., Pastor-Corrales, M.A., and Otoyá, M.M. 1990. Variabilidade patogênica de *Colletotrichum lindemuthianum* no Estado de Santa Catarina. Fitopatol. Bras. 15:243-245.
- Drijfhout, E. and Davis, J.H.C. 1989. Selection of a new set of homogeneously reacting bean (*Phaseolus vulgaris*) differentials to differentiate races of *Colletotrichum lindemuthianum*. Plant Pathol. 38:391-396.
- Melotto, M., and J.D. Kelly. 2000. An allelic series at the *Co-1* locus conditioning resistance to anthracnose in common bean of Andean origin. Euphytica 116:143-149.
- Pastor-Corrales, M.A. 1991. Estandarización de variedades diferenciales y de designación de razas de *Colletotrichum lindemuthianum*. Phytopathology 81: 694.
- Young, R.A., Melotto, M., Nodari, R.O., and Kelly, J.D. 1998. Marker assisted dissection of oligogenic anthracnose resistance in the common bean cultivar, G2333. Theor. Appl. Genet. 96:87-94.