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A Radiation-induced Mutant with Resistance to Common Bacterial Blight Disease in Common Beans

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Abstract. The leaf reaction of the *Phaseolus vulgaris* L. germplasm—UNECA (M₆ mutant derived from the cultivar Chimbolito, Costa Rica), ‘Chimbolito’, BAC-6 (Brazil), XAN-159 (Centro Internacional de Agricultura Tropical, Cali, Colombia), and ‘PC-50’ (Dominican Republic)—to *Xanthomonas campestris* pv. *phaseoli* strain V₄S₁ (Dominican Republic) were determined in two replicated trials conducted in a greenhouse in Lincoln, Neb. (Feb.–Mar. and July–Aug. 1993). ‘PC-50’ and ‘Chimbolito’ were susceptible to *Xcp* strain V₄S₁ in both tests. UNECA, BAC-6, and XAN-159 had similar levels of resistance to *Xcp* in the July to August trial. However, in the February to March trial, the resistance of UNECA was greater than that of BAC-6 but less than that of XAN-159.

Common bacterial blight disease, incited by *Xanthomonas campestris* pv. *phaseoli* (Smith) Dye (*Xcp*), is a major disease of common bean (*Phaseolus vulgaris* L.) (Yoshii, 1980). Emphasis has been placed on breeding bean cultivars resistant to *Xcp* (Coyne and Schuster, 1983). Dry-bean lines and cultivars with moderately high levels of resistance to *Xcp* (Coyne and Schuster, 1983; McElroy, 1985; Scott and Michaels, 1992) have been developed from interspecific hybridization of *P. vulgaris* with *P. acutifolius* A. Gray (Alvarez et al., 1981; Honma, 1956; Parker, 1985; Thomas and Waines, 1984). A mutant (M₄) bean line A-8-40, produced by gamma radiation of a *P. vulgaris* ‘Zarya’, was resistant to *Xcp* strains in Bulgaria (Zogorcheva and Poriazov, 1983). Subsequently, a single major recessive gene was reported to control resistance to *Xcp* in crosses of resistant plants made in A-8-40 to navy bean lines at Michigan State Univ., East Lansing (Adams et al., 1988).

Materials and Methods

UNECA, a black-seeded mutant (M₆) indeterminate line (Type III growth habit), selected for increased seed size, was received from Willy Navarro-Alvarez, Escuela de Ciencias Agrarias, Universidad Nacional, Apartado 86, Heredia, Costa Rica. UNECA was derived by treating the imbibed seeds of black-seeded ‘Chimbolito’ (Costa Rica) with 10-K rad treatment of gamma rays (W. Navarro-Alvarez, personal communication, 1992). Because of the importance of bacterial blight, we decided to determine the reaction of this mutant line to a virulent isolate of *Xcp*.

The leaf reactions of UNECA, ‘Chimbolito’, BAC-6 (Mohan, 1981) (Brazil), XAN-159 (McElroy, 1985) (Centro Internacional de Agricultura Tropical, Cali, Colombia) (the latter two were resistant controls), and ‘PC-50’ (F. Saladin, Secretaria de Estado de Agricultura, San Cristobal, Dominican Republic) (susceptible control) to *Xcp* were evaluated. Seeds of these lines were planted in clay pots containing (1.8 liters) a potting mixture of equal parts (by volume) Sharpsburg silty clay soil, sand, peatmoss, and vermiculite. The pots were arranged in a randomized complete-block design (RCBD) with three replications, each consisting of four pots (two plants per pot) of each bean line. Seeds were sown in a greenhouse in Lincoln, Neb., on 11 Feb. 1993 (mean daylength February to March, 10.4 to 11.5 h) and also on 22 July 1993 (mean daylength July to Aug., 14.6 to 13.3 h). Day/night averages for Feb.–Mar. 1993 were 27 ± 2C and 21 ± 2C, respectively, and for July–Aug. 1993, they were day 27 ± 2C/night 22 ± 1C and day 29 ± 2C/night 22 ± 2C, respectively. The plants were grown under natural daylength and were fertilized weekly with a 9N–3.5P–16.5K fertilizer containing trace elements.

The first trifoliolate leaves of 3-week-old plants were inoculated with *Xcp* strain V₄S₁ (Dominican Republic). The inoculum concen-

tration was 1.5 × 10⁷ colony-forming units/ml in a 12.5 mM standard potassium buffer with 10 mM magnesium sulphate. We used the multiple-needle method of inoculation (Andrus, 1948). Two leaflets of each trifoliolate leaf were inoculated with *Xcp*; the third leaflet was inoculated with only potassium buffer (control).

The disease reaction was recorded 15 days after inoculation by visual inspection as the percentage of the inoculated leaf area developing common bacterial blight symptoms, such as necrosis, water soaking, or chlorosis. The mean percentage of the inoculated leaf area with common blight symptoms was recorded for eight plants per replication. A combined analysis of variance over planting dates was performed using arcsin-transformed values, and treatment means were separated using Duncan’s multiple range test at *P* ≤ 0.05.

Results

The cultivar/line × planting date interaction (*P* = 0.006) was significant; thus, the means of cultivars/lines are presented separately for each planting date (Fig. 1). The mutant UNECA was resistant to *Xcp*, but ‘Chimbolito’ and ‘PC-50’ were susceptible at both planting dates. The disease resistance of UNECA in the February planting was significantly greater than that of BAC-6 (resistant control). Only slight symptoms (<2% inoculated leaf area with symptoms) developed on XAN-159 in the February planting. Similar levels of resistance (>15% and <20% inoculated leaf area with symptoms) were observed on UNECA, BAC-6, and XAN-159 in the July planting. In subsequent replicated (RCBD) greenhouse tests, the resistance of UNECA was confirmed with four isolates of *Xcp* from the Dominican Republic and Nebraska (A. Dursun, Univ. of Nebraska, Lincoln, unpublished data) and also under natural infection with *Xcp* in a replicated trial (RCBD) in the field in the Dominican Republic in the winter season (Eladio Arnaud Santana, Arroyo Loro Expt. Station, San Juan de la Maguana, Dominican Republic, unpublished information).

A genetic association was reported (Coyne et al., 1973) between late flowering and maturity and resistance to common blight in germplasm derived from a *P. vulgaris* × *P. acutifolius* cross (Honma, 1956), but Mohan (1981) reported no association between these traits. Flowering and maturity of UNECA were 7 to 10 days earlier than that of ‘Chimbolito’ under greenhouse conditions at both planting dates (data not presented). Thus, in our study, earliness was associated with resistance to *Xcp* in the UNECA mutant.

A. Dursun (Univ. of Nebraska, unpublished data) determined that resistance to three strains of *Xcp* was by two complementary dominant genes in the cross of the UNECA mutant with ‘Chimbolito’. This inheritance pattern for resistance differs from that of Adams et al. (1988), who reported a recessive gene determining resistance to other *Xcp* strains in crosses of a gamma-radiation-produced snapbean mutant A-8-40.

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The UNECA mutant line was derived from a tropical adapted meso-American cultivar and may be useful in breeding for resistance to *Xcp* under tropical conditions because of the poor adaptability in the tropics of common bacterial-blight-resistant germplasm developed in temperate regions (Beebe and Corrales,

1991). There was instability of resistance to *Xcp* in progenies derived from common-blight-resistant bean germplasm originating from other bean species. UNECA may have a gene(s) for resistance to *Xcp* different from those in the currently available bean germplasm derived from *P. acutifolius*. If this dif-

ference has a genetic basis, breeders may be able to recombine different genes from tepary germplasm with those from the UNECA and A-8-40 mutants (Adams et al., 1988) to develop greater levels of resistance to *Xcp*.

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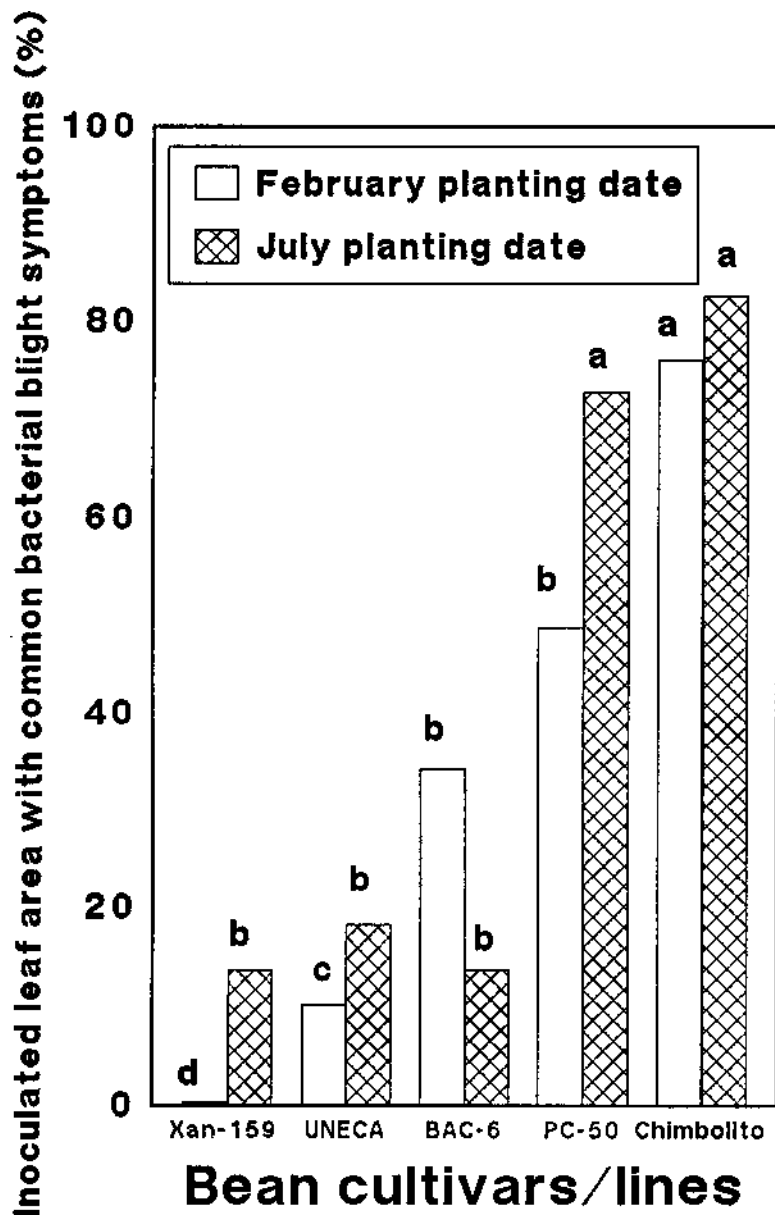


Fig. 1. Mean percentage of inoculated leaf area with common bacterial blight symptoms of common bean cultivars/lines at two planting dates. Mean separation for entries within a planting date by Duncan's multiple range test at $P \leq 0.05$.