INHERITANCE OF RESISTANCE AND ASSOCIATIONS OF LEAF, POD, AND SEED REACTIONS TO COMMON BACTERIAL BLIGHT IN COMMON BEANS.

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Common bacterial blight (CBB), incited by Xanthomonas campestris pv. phaseoli (Smith) Dye (Xcp), is a serious disease affecting production of common beans (Phaseolus vulgaris L.). Some Xcp resistant common bean cultivars and lines have been developed (Coyne & Schuster, Agr. Expt. Sta. Bul. UNL, 506, 1969; Michaels, Ann. Rep. Bean Imp. Coop. 35:40-41, 1992). The inheritance of disease reactions of leaf, pod (Coyne & Schuster, Euphytica. 23:195-204, 1974; Park & Dhanvantari, Can. J. Plant Sci. 67:685-695, 1987), and seed (Arnaud-Santana et al., J. Amer. Soc. Hort. Sci. 119(1):116-121, 1994) to Xcp have been reported. Low heritability (H) estimates of the leaf and pod reaction to Xcp in dry beans have been reported (Coyne et al., Proc. Amer. Soc. Hort. Sci. 86:373-379, 1965; Arnaud-Santana et al., J. Amer. Soc. Hort. Sci. 119(1):116-121, 1994). It is important to obtain more information on the inheritance, H of reaction of common beans to Xcp and on the association of reactions to Xcp in various plant parts and with other traits. The objectives of this research were to study (a) the inheritance and H of leaf and pod reactions and seed infection to Xcp in common bean crosses along with flower color and stem color and (b) the association among leaf and pod reactions and seed reactions to infection by Xcp.

Materials and Methods: Recombinant inbred (RI) F₈ lines from the bean cross ‘PC 50’(S) x XAN 159 (R), RI F₈ lines from the cross BAC 6 (R) x HT 7719 (S), and RI F₆ lines from GN BelNeb 1 (R) x A 55 (S) were planted using a RCBD with 2 replications in 3 separate experiments in the greenhouse, University of Nebraska-Lincoln. Since the time of flowering occurred within 10 days for all lines, some pods were at a suitable and the same stage of development for inoculation at the same time. This was done to reduce environmental variation affecting the disease reactions. If different pods were inoculated repeatedly over an extended time period, the pod reactions might be affected by variations of temperature in the greenhouse. The approximate greenhouse day/night temperatures were 28±3 / 22±2, C 27±2 / 22±2 C, and 29±3 / 23±2 C for 3 experiments, respectively. The average natural day lengths were 10, 11 and 14 hrs during these experiments, respectively. The day lengths were extended to 12 hrs in the first two experiments using metal halide lamps.

Xcp strain Vₛ₈ was used for all inoculations. The multiple needle method (Andrus, Phytopathology 38:757-759, 1948) was used to inoculate the first trifoliolate (FTL) and later fully developed leaves behind the growing point (LDL). A Pipetteman was used to inoculate pods at the seed filling stage. Also LDL were inoculated at the same time as the pods. Leaf (% of inoculated leaf area with disease symptoms) and pod (length of lesion from the point of inoculation) disease reactions were recorded 14 days after inoculation. To test seed infection, seeds were placed on MXP culture plates and incubated at 27 C in darkness. After five days the number of infected seeds was recorded. Narrow sense heritabilities for the reactions to Xcp were calculated using the components of variance method (Fehr, Principles of Cultivar Development. Theory and Technique, 1987).
Results and Discussion: Continuous distributions for leaf reactions were observed for all leaf stages in all populations indicating quantitative inheritance patterns of the reactions. Clear bimodal distributions for disease reactions of pods to Xcp were observed for RI lines in the crosses BAC 6 x HT 7719 and BelNeb 1 x A 55. It is hypothesized that the reactions to Xcp in these crosses were determined primarily by only one or two genes.

Low to intermediate and intermediate to moderately high H estimates were obtained for leaf (0.30-0.60) and pod (0.49-0.76) reactions (Table 1). The H estimates for leaves (0.31) and seeds (0.41) in RI lines 'PC 50' x XAN 159 were similar to those found by Arnaud Santana et al., (J. Amer. Soc. Hort. Sci. 119(1):116-121, 1994) in that cross. In our experiment, we observed high H estimates for pod reactions. This is attributed to pod inoculations being conducted at the same time. The above authors inoculated pods over several days, due to segregation for number of days to flowering in the RI lines and this could have resulted in an increase of environmental variance, thus reducing H estimates. The RI lines from the other two crosses BAC 6 x HT 7719 and BelNeb 1 x A 55, showed moderately high H estimates for reactions to Xcp in the first trifoliolate leaves (0.60 and 0.54), later developed leaves (0.54 and 0.52) and pods (0.74 and 0.76). Intermediate H estimates were found for seed reactions to Xcp in RI lines 'PC 50' x XAN 159 (0.41) and BAC 6 x HT 7719 (0.45) agreeing with results obtained for the former cross by Arnaud Santana et al., (J. Amer. Soc. Hort. Sci. 119(1):116-121, 1994).

Significant positive intermediate Pearson correlations (rₚ) were observed between disease reactions of FTL with LDL (+0.54 to +0.69) and pods (+0.49 to +0.75) in all three populations except for a moderately low rₚ between FTL and pods (+0.49) in 'PC 50' x XAN 159 RI lines. Moderately high genetic correlations (r₉) between leaves and pods (+0.55 to +0.81) suggested that some common genes may control disease reactions in leaves and pods. Low, but significant r₉ were observed between seed reactions and FTL (+0.36 and +0.19) or LDL (+0.28 and +0.19) reactions in RI lines 'PC 50' x XAN 159 and BAC 6 x HT 7719, respectively. These results suggested that there may be some different genes controlling the reactions to Xcp in seeds and leaves. At least one or more seeds in highly infected pods showed common blight symptoms, while occasionally a seed in non infected pods also showed symptoms. This may be one of the reasons why low rₚ and r₉ were observed. No significant associations were detected between the reactions to Xcp with the stem or flower color in crosses 'PC 50' x XAN 159 and BelNeb 1 x A 55.

The improved H estimates indicated that phenotypic data obtained from these populations could be used to better map Quantitative Trait Loci (QTLs) controlling reactions to Xcp. Selection efficiency for the resistance to Xcp may be increased using molecular markers such as RAPDs.