GENETIC VARIATION AND GENOTYPE X ENVIRONMENT INTERACTION FOR LEAF IRON-DEFICIENCY CHLOROSIS IN DRY BEANS (PHASEOLUS VULGARIS L.)

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Iron-deficiency chlorosis is a common disorder for many plants grown on alkaline calcareous soils. As much as 25-30% of the agricultural land in the world has crop problems of leaf iron chlorosis resulting in yield reduction.

Dry bean (Phaseolus vulgaris L.) breeders are interested in the development and/or selection of lines and release of cultivars with high resistance to iron-deficiency chlorosis symptoms under calcareous soil conditions. Genetic variation and the effect of temperature on the expression of this trait was presented in an earlier BIC report (Vol. 29, 1986, p. 34). The objectives of the research were to determine additional bean cultivars/breeding lines for resistance, to select resistant breeding lines, and to look for additional evidence of genotype x environment interaction for iron chlorosis in the field.

The Nebraska (NE) Great Northern (GN) breeding lines evaluated in this nursery were developed for avoidance to white mold (avoidance due to upright open plant habit) and common blight bacterial diseases and tested for reaction to those pathogens in separate nurseries.

Forty dry bean cultivars/lines were evaluated in 1986 for leaf iron chlorosis on a highly calcareous soil site at the Panhandle Agriculture Research and Extension Center, University of Nebraska, Scottsbluff, NE. The experimental design was a randomized complete block design with 5 replications. Each plot consisted of 3 rows, 5 m long. The experiment was planted June 3, 1986 and leaf chlorosis ratings were recorded at early bloom. The rating scale used was as follows: 1 = normal green leaves (highly resistant), 2 = trace of chlorosis on an occasional leaf (resistant), 3 = moderate chlorosis on several leaves (moderately susceptible), 4 = moderately severe chlorosis on most leaves (susceptible), and 5 = severe chlorosis on all leaves (highly susceptible).

The cultivars/lines differed in the severity of iron chlorosis symptoms and showed a continuous variation in symptoms ranging from high resistant to susceptible. Some of the highly resistant cultivars/lines (no symptoms) were G.N. 'Sapphire', Pinto 'UI 111', A-55 (Black-CIAT), G.N. WM1-85-46 (NE), and G.N. WM1-86-40 (NE). Some of the resistant (trace of chlorosis) cultivars/lines were Pinto 'Olathe' (Co), Pinto D84343, G.N. WM1-85-43 (NE), G.N. WM1-85-47 (NE), and G.N. CB-85-57 (NE). Some of the intermediate resistant cultivars/lines were G.N. 'Tara', G.N. 'Harris', G.N. 'Spinel', G.N. 'Beryl', Pinto 'Agate', G.N. WM1-85-35 (NE), G.N. WM1-85-39 (NE), G.N. WM1-85-41 (NE), G.N. WM1-85-51 (NE), G.N. ND-85-36 (NE), and Pinto WM1-86-39 (NE). Some of the intermediate susceptible cultivars/lines were G.N. 'Ivory', G.N. 'UI 59', Tacaragua (Venezuela-Black), PI 169787,

G.N. WM1-85-31 (NE), SW 78048, G.N. WM1-85-42 (NE), G.N. WM1-85-45 (NE), G.N. WM1-85-49 (NE), G.N. WM1-85-50 (NE), G.N. WM1-85-52 (NE), G.N. WM1-85-54 (NE), G.N. WM1-85-55 (NE), and G.N. ND-85-48 (NE). Some of the most susceptible cultivars/lines were Pinto 'Topaz', Midnight (Black), Navy-'ExRico', Dark Red Kidney 'Montcalm', and G.N. WM1-85-48 (NE).

Eleven of these 40 cultivars/lines were previously screened for iron-deficiency chlorosis under field conditions in a calcareous soil in 1983. A genotype x environment interaction was noted between 1983 and 1986. The following cultivars/lines behaved differently in these 2 field experiments: G.N. 'Tara', G.N. 'Harris', Midnight (Black), Navy-'ExRico', and Dark Red Kidney 'Montcalm'. The following cultivars/lines behaved the same: G.N. 'Spinel', G.N. 'Ivory', G.N. 'Beryl', Pinto 'Agate', Pinto 'UI 111', and G.N. 'Sapphire'. Differences in temperature, soil moisture, and other external factors may have had a marked effect on the degree of leaf iron chlorosis expressed in the cultivars/lines between the 2 years.

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TEMPERATURE, GRAFTING METHOD, AND ROOTSTOCK INFLUENCE ON IRON DEFICIENCY INDUCED CHLOROSIS OF BEANS (PHASEOLUS VULGARIS L.)

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Two resistant (Great Northern 'Emerson' and Neb-WM1-83-10) and 2 susceptible (PI 165078 and 'Stueben Yellow Eye') cultivars/lines of dry bean (Phaseolus vulgaris L.) to iron (Fe) deficiency chlorosis, and their reciprocal graft combinations (2 methods) were grown in pots in calcareous soil which was known to induce Fe deficiency chlorosis in a growth chamber under low (24/13 °C) and high (29.5/18.5°C) temperature regimes and 15 and 9 hrs of light and dark period, respectively. A split-plot design with 2 replications (time) was used with temperature regimes as main plots.

Both Neb-WM1-83-10 and G.N. 'Emerson' scions (resistant) grafted onto 'Stueben Yellow Eye' and PI 165078 rootstocks (susceptible) developed leaf chlorosis when plants were grown at the low temperature regime. On the other hand, 'Stueben Yellow Eye' and PI 165078 scions grafted onto Neb-WM1-83-10 and G.N. 'Emerson' rootstocks were green or had lower chlorosis ratings than scions grafted on susceptible rootstocks. Apparently, the Neb-WM1-83-10 and G.N. 'Emerson' rootstocks absorbed more Fe from the calcareous soil than 'Stueben Yellow Eye' and PI 165078 rootstocks. Neb-WM1-83-10 and G.N. 'Emerson' rootstocks absorbed and translocated sufficient Fe to prevent or reduce visual chlorosis in the leaves of both 'Stueben Yellow Eye' and PI 165078 dry beans. Rootstalks of dry beans thus controlled uptake or utilization of iron (Fe).

Iron chlorosis was more severe when plants were grown under the 24/13°C regime (light/dark period) than when plants were grown under the 29.5/18.5°C regime. This probably occurred because of an increase in growth, especially roots, and on metabolic activity of the roots rather than because of chemical changes of Fe in the soil .