Dissection of Potato Leafhopper (*Empoasca fabae* Harris/ *Empoasca kraemeri* Ross and Moore) Damage Symptoms in the Common Bean (*Phaseolus vulgaris* L.).

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ABSTRACT. Typical presentation of potato leafhopper injury in beans includes necrosis at the leaf margins (leaf burn or hopperburn), and downward curling or "cupping" of the leaves. To evaluate potato leafhopper damage a visual score that combines the overall severity of leaf burn, leaf curling and stunting symptoms is usually used. Nonetheless, it may be useful to evaluate these symptoms separately since they be the result of separate mechanisms of damage, inhibited by separate resistance genes. A population of 108 recombinant inbred lines (RILs), derived from a cross between a leafhopper-susceptible Ontario cultivar (Berna) and a resistant line (EMP 419) where scored for injury after natural infestation with *Empoasca fabae* in Canada and *Empoasca kraemeri* in Colombia. Leaf burn and leaf curl were significantly rank-correlated (0.37-0.74, $P<0.001$) in all environments. However, several RILs consistently exhibited high scores for leaf curl but low values for leaf burn, which suggests that genetic dissection of these characters may be possible.

INTRODUCTION. Leafhopper damage on bean typically begins with slight leaf curling, progressing to severe downward cupping of the leaves. In highly susceptible plants the leaf curl is accompanied by leaf yellowing which, in the most severe cases, leads to necrosis and subsequent browning of the leaf margins and interveinal areas (1). To evaluate susceptibility/resistance of lines plant breeders often use an index that reflects the percentage of damaged leaves or the combined overall severity of symptoms relative to control cultivars with known responses. This approach is efficient when plant selections are the desired objective and many lines need to be evaluated. But genetic dissection of leafhopper resistance is likely to yield several loci that contribute differently to preventing different damage symptoms. For this reason, it is useful to score each damage type separately. We have established recombinant inbred lines (RILs) to determine the relationships between the various damage components and to investigate the role of growth habit and seed-coat colour in leafhopper resistance in the common bean. These RILs are being used to identify molecular markers linked with resistance loci.

METHODOLOGY. The studies were conducted at two locations in Ontario, Canada, Ridgetown and Harrow and at Cali, Colombia (CIAT). The predominant species of leafhopper in Ontario is *Empoasca fabae,* which is a migratory insect that is incapable of overwintering in this region. In the Cauca Valley, Colombia populations of *Empoasca kraemeri*, the principal leafhopper species in this part of the world, are present throughout the year. Recombinant inbred lines were derived from a reciprocal cross between Berna, a Dutch brown bean, which is highly susceptible to leafhopper, and EMP 419, a resistant white-seeded line developed in CIAT's recurrent selection breeding program. Approximately 150 F_2 plants were advanced to F_5 by single seed descent. The $F_{5:6}$ lines were planted in a completely randomized design in single row plots, 3 m in length at 20 plants/row Ridgetown and Harrow. The plots were evaluated for leaf burn and leaf curl at 56, 61 and 76 DAP at Ridgetown and 49 and 62 DAP at Harrow. The $F_{5:7}$ material was evaluated separately for leaf burn and leaf curl damage at 37 and 38 DAP at a single location at CIAT. Correlation analysis was based on the evaluations exhibiting maximal damage.

RESULTS AND DISCUSSION. Mean leaf burn and leaf curl damage scores for the $F_{5:6}$ lines were significantly (P <0.001) rank correlated at all locations but they were higher at the ON locations (0.60-0.74) than at CIAT (0.37)(Table 1). The observation that the ranks of both burn scores and curl scores were more highly correlated between locations in Ontario than they were between either Ontario location and Colombia may be due to differential feeding behaviour between the species of leafhoppers predominant in each area. Another factor that may have contributed to these differences is that *E. kraemeri* populations are present year-round in Colombia and are thus well established during emergence of the bean seedlings. In contrast, *E. fabae* does not overwinter in Ontario and populations are often low at bean seedling emergence. A Venn diagram (Fig 1) illustrates that some genotypes consistently exhibited a 'differential damage' phenotype characterized by leaves that had high leaf curl scores but low leaf burn scores. The existence of these lines suggests that resistance to leaf burn and leaf curl damage are, to some degree, separable traits.

Table 1. Spearman's rank correlations (r_s) of mean leaf burn and mean leaf curl damage scores for three locations

Location	r_s*
Ridgetown	0.74
Harrow	0.60
CIAT	0.37

*all correlations are significant at P<0.001

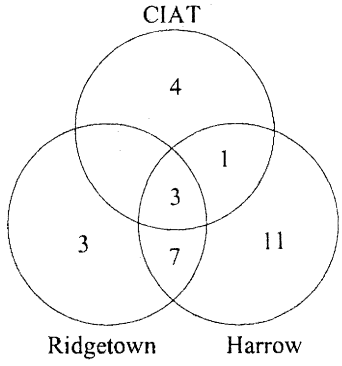

Figure 1. A Venn diagram showing the number of differential (burn score≤2, curl score≥4) genotypes in each environment.

CONCLUSIONS. There were significant correlations between leaf burn and leaf curl scores at all locations for both species of leafhopper. However, our results suggest that there may be some genotypes that are differential in the severity of leaf burn and leaf curl. In particular, some inbred lines were identified that consistently exhibited severely curled leaves but had minimal hopperburn in several environments. Separate scoring of these traits may permit leafhopper resistance to be dissected into separate mechanisms determined by genes at loci that potentially contribute to either leaf burn or leaf curl symptoms. The determination of the relative effects of these traits on yield will be useful to bean breeders screening for leafhopper resistance.

REFERENCES.

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