Screening the USDA Core Collection of Common Bean for Resistance to Halo Blight Under Greenhouse and Field Conditions

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OBJECTIVES

- To screen the United States Department of Agriculture-National Plant Germplasm System (USDA-NPGS) Bean Core Collection for resistance to race 6 of halo blight, *Pseudomonas syringae* pv. *phaseolicola* (*Psp*) under greenhouse conditions.
- To further evaluate disease reactions in a group of selected accessions when inoculating leaves vs. pods of the same plant under greenhouse and field conditions.

INTRODUCTION

- Halo blight, caused by *Pseudomonas syringae* pv. *phaseolicola* (*Psp*) is an important seed-borne bacterial disease of common bean (*Phaseolus vulgaris* L.).
- Under favorable conditions, yield losses on susceptible common bean cultivars may reach up to 45%.
- A chlorotic area of yellow-green tissue on leaves resembling a halo may appear around necrotic lesions, a characteristic symptom of disease (Fig. 1). Severe infections may result in systemic chlorosis extending to stems and pods (Fig. 2).
- Several sources of resistance to *Psp* have been identified along with five putative genes (Taylor *et al.*, 1996). However, to date, no dry bean cultivars with high levels of resistance to race 6 of *Psp* are commercially available.

Figure 1. Necrotic lesions on the leaves surrounded by a characteristic chlorotic halo.

Figure 2. Reddish brown water-soaked lesions on pods exhibiting bacterial ooze on the surface.

Figure 3. Layout of experimental field in Perham, Minnesota, 2014.

Figure 4. Inoculation using multiple-needle florist pin frog method.

ACKNOWLEDGMENTS

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Figure 5. Lsmeans disease severity scale (Unifoliate) of ten most resistant accessions and the 2 control cultivars to halo blight infection in the greenhouse.

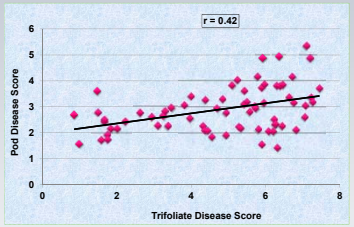

Figure 7. Pearson correlations for trifoliate and pod halo blight disease reactions to *Psp* under greenhouse conditions.

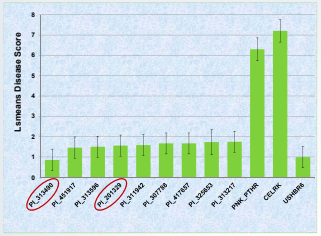

Figure 6. Lsmeans disease severity scale (Trifoliate) of ten most resistant accessions and the 2 control cultivars to halo blight infection in the greenhouse.

Figure 8. Lsmeans disease severity scale (Trifoliate) of ten most resistant accessions and the 2 control cultivars to halo blight infection under field conditions.

MATERIALS AND METHODS

PLANT MATERIALS AND EXPERIMENTAL DESIGN

- Screening of 283 plant accessions (PIs) for unifoliate reactions to *Psp* under greenhouse conditions in an RCBD with four replicates. Pink Panther, a light red kidney, and USHBR6, a resistant pinto line, were used as susceptible and resistant check, respectively.
- A group of 81 selected PIs, comprised of 37 resistant and 25 susceptible along with 19 standard cultivars (checks), were arranged in a 9 x 9 alpha-lattice design for trifoliate and pod evaluation (within same plant) in the greenhouse.
- A group of 49 selected PIs, comprised of 30 resistant PIs plus 19 standard cultivars (checks), from above were evaluated for trifoliate and pod reactions under field conditions arranged in a 7 x 7 alpha-lattice design. California early light red kidney (CELRK) and USHBR6 were used as susceptible, and resistant checks, respectively. Four plants within each plot were randomly selected, flagged, inoculated, and disease observations were recorded over the entire phenological cycle.
- Due to the lack of available seeds, some PIs that showed resistant reactions to halo blight disease under greenhouse conditions were arranged in a 5 x 5 alpha-lattice design as observation rows in the field and data was recorded.

INOCULATION AND DISEASE EVALUATION

- An individual unifoliate from each of PIs was inoculated at the V-2 growth stage with a 48 h old *Psp* race 6 culture at a density of $1x10^8$ cfu/mL using the multiple-needle florist pin frog method (Mills and Silbernagel, 1992).
- Trifoliate leaves were inoculated 21 d after sowing, while pods were inoculated at about one-half (R4) to three-fourth (R5) of their respective mature stages.
- Inoculated plants were rated 10 d after inoculation using a disease severity scale of 1 – 9 [1-3 = resistant (R), 4-6 = intermediate (I), 7-9 = susceptible (S)] (Mills and Silbernagel, 1992).

STATISTICAL ANALYSIS

- Halo blight disease severity data were analyzed using PROC MIXED METHOD = TYPE3 for genotypic and time reactions.
- Lsmeans were separated using *pdiff* to classify categories of resistance between accessions at $\alpha = 0.05$.
- The correlation between the trifoliate and pod reactions to *Psp* bacterium of 81 PIs was analyzed using PROC CORR (SAS Institute, 2012).

RESULTS AND DISCUSSION

- Greenhouse:
  - Out of 283 PIs in the greenhouse, 37 were resistant, 219 intermediate, and 25 susceptible for unifoliate reactions.
  - Of the 37 resistant PIs, 10 had higher levels of resistance to *Psp* compared to resistant check, USHBR6, with an average disease score of 1.5 (Fig. 5).
  - Of 81 selected PIs, 30 showed significantly higher levels of trifoliate resistance to *Psp* (Fig. 6).
  - No significant correlation ($P<0.05$) was observed between the trifoliate and pod (within the same plant) reactions to *Psp* (Fig. 7).
    - Suggests the differences in reaction of *Psp* across plant developmental stages might be controlled by different genes.
- Field:
  - PI_201329 and PI_313490 (circled in red) showed consistent resistant reactions to *Psp* in terms of unifoliate and trifoliate reactions under both greenhouse and field conditions (Fig. 8). These PIs also showed slower progression of disease across time under field conditions (Fig. 9).
- The superior performance of PI_313490, a black bean from Puebla, Mexico, across all conditions and organs (leaves and pods) suggests it may be a potential source of resistance to *Psp*.

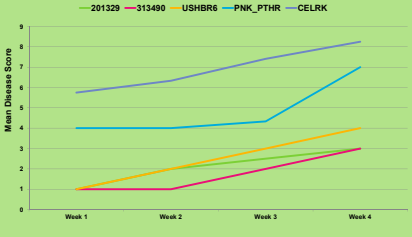

Figure 9. Response of resistant plant accessions to halo blight disease reactions in trifoliates across four weeks under field conditions.

FUTURE RESEARCH

- Data on pod reactions from a group of 49 selected PIs under field conditions will be analyzed.
- Genomic regions linked to resistance will be later identified using GWAS with the 283 accessions.

REFERENCES

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