USDA Work on Fusarium Root Rot of Dry Beans at Prosser, Wa.

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Both a breeding program and a study of soil factors affecting bean roots in their relationship to the Fusarium are being continued.

Breeding: Fusarium-resistant lines developed in the past have largely fallen by the wayside, because, although they performed well under conditions where commercial cultivars were badly damaged by root rot, they were excessively viny and late in maturity when grown under more favorable conditions. However, from this earlier work we do have some promising material including an excellent strong-rooting Red Mexican selection, AR 58-4, which we propose to release this winter.

More recently breeding has included the intercrossing of breeding lines carrying resistance or field tolerance from various sources. Our most promising early-maturing selections are from crosses involving Sutter Pink, Pinto UI 114, and Black Turtle Soup, all of which we find fairly tolerant of root rot.

Other than in the selection of Fusarium-resistant plants, we seldom examine roots for degree of infection. Our principal test for Fusarium tolerance is yielding ability under disease stress. All segregating material is grown in Fusarium-infested fields. Selections in F_2 and F_3 generations are made on the basis of plant type, early maturity and vigor of the plant and roots compared to control plants. Curly top eliminations are usually accomplished by natural infection in early generations. Beginning with the F_4's or F_5's, single-row seed yields are recorded, and the highest-yielding, commercial types are retained. Mosaic tests are applied to the best materials. The best mosaic-resistant selections are included in replicated 4-row-plots in field trials at Prosser and Othello. Our present policy is to discard nearly all lines which require more than 95 days to mature (planting time to cutting).

We are interested also in ability of selections to germinate in, or survive, cold soil conditions and to produce in spite of this and other vicissitudes. We also want to know their performance under favorable conditions. Therefore, they are planted about May 1, at Othello, usually in cold soil with low fertility. At Prosser they are planted in fertile soil after mid-May when the soil is frequently warm.

Ecological and Cultural Studies: We have been impressed over the years with the variation in severity of root rot in fields where the Fusarium is uniformly prevalent. Bean growth and yields in such fields vary with time of planting and location from excellent to very poor. This variation we have found is related mainly to within-field variations in soil compaction and soil moisture distribution. The effect of time of planting evidently relates to soil temperature and its effects both on vigor of root growth and on the pathogen.

Our recent field and laboratory studies with D. E. Miller, ARS Soils Physicist, have shown that soil compaction restricts root growth and thereby aggravates root rot. However, if the soil is loosened or sufficient soil moisture is supplied, even with soil compaction, root rot may be counteracted.

In other words, one of the detrimental effects of soil compaction in Fusarium-soil is reduced root exposure to soil moisture. Also, we have found that soil compaction aggravates root rot less at soil temperatures of 70° to 80°F than at 60°F, possibly explaining why warm soil helps the plant overcome the effects of root rot. Presently, we are also studying the effect of aeration as related to the interaction of soil compaction, soil moisture and the disease.

We have found that bean rows near tractor wheel tracks in sandy loam soil are greatly reduced in yield in Fusarium-infested fields but not in non-infested fields. This past season chiseling the wheel tracks 15-18 inches deep, at time of plant emergence largely overcame the packing effect on yields.

Other extensive field experiments designed to help develop practical means of preventing or eliminating the effects of soil compaction on bean root rot gave promising results in 1973.

A field study, repeated for the third year, demonstrated detrimental effects of too much irrigation water in the root rot problem. We have not yet determined whether the damage is caused by a slumping and compaction of the saturated soil or by a temporary aeration problem, or both. Here, again, such damage is much more pronounced in Fusarium-infested than in non-infested fields.

A three-year study with J. M. Kraft, in which beans and peas have been planted reciprocally in fields where root pathogens had accumulated during many years of monoculture of each crop species, showed that pathogens common to both species, Rhizoctonia solani, Thielaviopsis basicola, and Pythium ultimum, did not reduce yields in the absence of the host-specific forms of Fusarium solani. Not until the third season of growing beans in the pea field was F. solani phaseoli sufficiently prevalent to reduce bean yields. The same was true of peas and the accumulation of F. solani pisi in the bean field. Three years' production of these crop species is usually also the time required for damaging infestations of these pathogens to develop in newly cultivated virgin land.

Summary of Snap Bean Root Rot Tolerance Program

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The incidence of root rot disease occurs with erratic and unpredictable frequency in the Plainfield sands of Central Wisconsin with moderate to severe yield losses every year. Since we are unable to locate any appreciable source of tolerance to the root rot complex in commercial varieties, we have used resistant sources cited in the literature in a breeding program. The three primary sources we are using are N203, P.I. 109-859 (red seeded), and P.I. 300-665. Using soil pot culture, crosses were made in a greenhouse to breeding lines, and F_1 plants were grown on benches. This eliminated contamination by bacterial or virus organisms associated with foliage diseases. F_2 plants were field-grown in a "disease nursery" on the Plainfield sands. The "disease nursery" is located where snap beans have been grown continuously for eight years and the soil disease level is uniformly fairly severe. Selections are made in F_2, F_3 and F_4.

Pure culture isolates have been taken from this soil of Pythium, Rhizoctonia, and Fusarium. Greenhouse tests were run (by Richard Morrison) with various concentration levels against the parent breeding lines singly and in combination. A determination was made as to the relative tolerance of the parent lines. These results conformed very closely with field results of the same lines. Segregation for disease tolerance has been readily apparent, and was confirmed in repeated plantings. Round-podded, white flowered segregates with acceptable levels of root rot tolerance have been identified and will be used for further crossing and selection work. Greenhouse bench testing and screening for disease tolerance in growth chambers will continue as the number of selections increases.

Root Rots of Snap Beans

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Our primary pathogen is Fusarium although Rhizoctonia and Pythium are sometimes quite damaging while Thielaviopsis though frequently found seems to be of minor importance. Most of our breeding efforts are aimed at Fusarium. Some of the better sources of tolerance are PI 165426, NY-2114-12 and PI 203598. So far we have not achieved as high a level of tolerance in white seeded breeding lines as in the resistant parents. Generally the closer the return to acceptable horticultural type through backcrossing, the less the root rot tolerance. Consequently in recent years we have been doing a lot of sib intercrossing hoping to combine tolerance from diverse sources while gradually selecting for improved horticultural characteristics. Root rot ratings are made on a 0-5 basis for