Slow Rusting in Dry Edible Beans

Glen D. Statler and **Ken Grafton**

Bean rust caused by the fungus *Uromyces phaseoli* (syn. *U. appendiculatus*) can be a serious disease of beans. Rust reached epidemic proportions in 1980 and 1981 (Venette and Lamey, 1986). The disease was so severe that some fields were not harvested. According to Venette and Lamey (1986), rust is most serious on late planted beans and on beans planted on or near fields previously planted to beans. They reported rust to be more severe when growing conditions are cool and moist. Rust can be controlled by resistant varieties but major gene resistance may not be permanent because this fungus can change by mutation or other means and parasitize previously resistant varieties (Groth and Roelfs, 1982; Stavely, 1984).

Slow rusting is a kind of resistance that appears to be race non-specific and more durable than major gene resistance in wheat (Ohm and Shaner, 1976). Slow rusting retards disease development in the field even when the infection type appears susceptible. Slow leaf rusting in wheat has been associated with a longer latent period (the time from spore germination to uredia formation), reduced uredial (pustule) size, and fewer uredia per unit area.

Partial resistance in barley is similar to slow rusting in wheat and is defined as a reduced rate of epidemic development in spite of a susceptible infection type (Parlevliet 1976). Partial resistance has been related to reduced infection densities (number of uredia divided by the number of spores applied), longer latent periods and reduced rates of sporulation (Parlevliet 1979). Partial resistance in barley has been considered to be relatively stable compared with race specific or major gene resistance.

This study was conducted to determine if slow rusting occurred in beans and, if so, which factors could be used to identify the slow rusting properties.

Materials and Methods

The bean varieties used in this study were UI 114 and Fiesta known to be susceptible to *U. phaseoli*, Nodak and Upland observed to have less rust in the field, and Pindak, observed to have smaller uredia. The variety Red Kloud was used as a hypersensitive resistant control to be sure necrosis could be distinguished from slow rusting by the staining procedure used.

*The author wishes to acknowledge the help of Dr. M.C. Edwards in preparation of figures and the technical assistance of M.A. McVey.

Statler is professor and Grafton is associate professor, Department of Plant Pathology.

Rust spots on bean leaves.

Seedlings of the cultivars were grown in a greenhouse at North Dakota State University. Primary bean leaves were inoculated with uredospores and placed in a growth chamber. About the same amount of inoculum was applied to each leaf with an inoculator. The number of spores applied was determined by counting spores on glycine coated slides. Inoculated plants were held at 100 percent humidity for 24 hours, then returned to a greenhouse bench.

Latent period was determined by counting the uredia each day until no more developed. The time between inoculation and 50 percent of the uredia sporulating (LP50) was calculated. Infection density (ID) was determined by dividing the total number of uredia per square centimeter by the number of urediospores applied.

Two sections from the central portion of two primary leaves from two plants were collected each day to day 14 after inoculation. Fluorescent microscopy was used to determine colony size, early and late abortion, proportion of successful penetrations, uredial size, and necrosis of the resistant variety, Red Kloud. Slow rusters can be separated from

hypersensitive resistance by the bright fluorescence of necrotic tissue in hypersensitive varieties compared to low fluorescense of slow rusters.

The fluorescent microscope study consisted of four replications of 10 colonies which had penetrated the stoma for each replication. The length and width of the sporulating area and mycelial growth were measured each sampling date.

Results and Discussion

A longer latent period has been correlated with partial resistance of barley to *Puccinia hordei* (Parlevliet and Kuiper, 1977) and with slow rusting of wheat (Ohm and Shaner, 1976). However, the latent periods of the five bean varieties inoculated with *U. phaseoli* were not significantly different in this study (Table 1). This indicated that latent period could not be used to determine slow rusting of bean cultivars.

Table 1. Latent period, number of uredia/cm², early abortion and late aborted infections in bean cultivars 14 days after inoculation with *Uromyces phaseoli*.

	Percentage early abortion[x]	Percentage late abortion[y]	Latent period (days)	Uredia per cm²
UI 114	16.0	2.5	8.7	11.6
Fiesta	17.0	7.5	7.9	10.4
Nodak	30.5	27.5	8.4	2.8
Pindak	20.0	7.5	8.3	8.0
Upland	34.7	17.5	8.0	5.1
LSD 0.5 =	12.23	3.81	0.71	5.84

LSD calculated from significant F test (P = 0.05).
[x]Percentage early abortion = number of colonies with little growth/total number of infection units (Avg. Day 3-14).
[y]Percentage late abortion = number of colonies with no sporulation on day 14/total number of colonies.

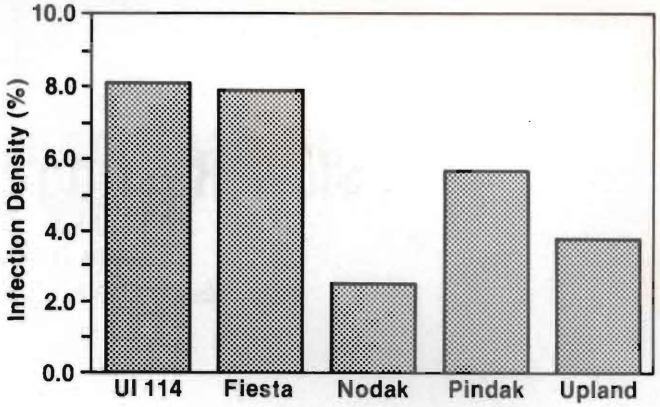

Figure 1. Infection density of five bean cultivars inoculated with *U. phaseoli*.

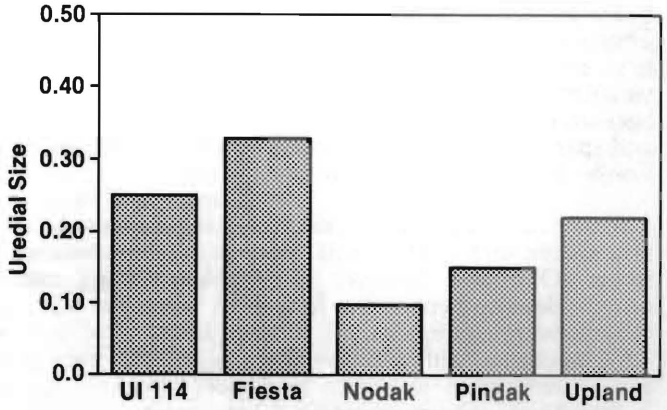

Figure 2. Uredial size of five bean cultivars inoculated with *U. phaseoli*.

Parlevliet and Kuiper (1977) found a high correlation between infection density (ID, the number of pustules divided by the number of uredospores applied) and slow rusting in barley. ID also appears to be correlated to slow rusting in Nodak and Upland (Fig. 1) since the ID was significantly (P = 0.05) lower than for UI 114. ID can therefore be used to screen bean varieties for slow rusting. The percentage of early and late aborted colonies was much higher for Nodak and Upland than for the other cultivars (Table 1). Those colonies that abort obviously do not produce uredia. This explains why the number of uredia per square centimeter and ID was lower for Nodak and Upland than for susceptible cultivars (Table 1, Fig. 1). Low numbers of uredia per square centimeter has also been associated with slow leaf rusting in wheat by Ohm and Shaner (1976). Niks (1982) found early abortion to be the most important component of low infectibility in barley to *P. hordei*. It appears that aborted colonies are also a very important component of slow rusting in beans (Table 1).

The susceptible cultivar Fiesta had the largest sporulating area at 14 days followed by UI 114 and Upland (Fig. 2). Nodak and Pindak had much smaller sporulating areas than the other cultivars. Smaller uredia have been associated with slow rusting of wheat to *P. recondita* (Ohm and Shaner, 1976). Smaller uredia obviously produce less inoculum, which retards development of epidemics.

The proportion of successful penetrations defined as the number of colonies with uredia divided by the total number of colonies at day 14 was much lower for Nodak and Upland (Fig. 3). This is also an important component of slow rusting and could be used to evaluate bean varieties. The proportion of successful penetrations is associated with the number of aborted colonies.

This study demonstrated slow rusting for Upland and Nodak with *U. phaseoli* (Fig. 1-3). These cultivars had lower IDs and fewer uredia per square centimeter than susceptible cultivars Fiesta and UI 114. Nodak and Upland had a higher percentage of both early- and late-aborted colonies than the susceptible cultivars, resulting in a lower proportion of successful penetrations. Nodak had much smaller uredia than the susceptible cultivars. The only component of slow rusting demonstrated for Pindak was small uredia. Several of the components of slow rusting studied; ID, proportion of successful penetrations, uredia size, and number uredia per square centimeter can be used to evaluate beans for slow rusting.

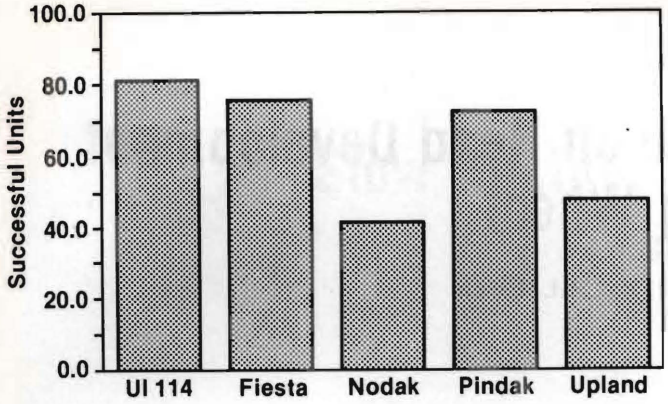

Figure 3. Proportion of successful penetrations of beans by *U. phaseoli*.

Literature Cited

1. Groth, J.V., and Roelfs, A.P. 1982. Genetic diversity for virulence in bean rust collections (Abstr.) Phytopathology 72:982.
2. Niks, R.E. 1982. Early abortion of colonies of leaf rust, *Puccinia hordei* in partially resistant barley seedlings. Can. J. Bot. 60:714-723.
3. Ohm, H.W., and Shaner, G.E. 1976. Three components of slow leaf-rusting at different growth stages in wheat. Phytopathology 66:1356-1360.
4. Parlevliet, J.E. 1976. Partial resistance of barley to leaf rust, *Puccinia hordei*. III. The inheritance of the host plant effect on latent period in four cultivars. Euphytica 25:241-248.
5. Parlevliet, J.E., and Kuiper, H.J. 1977. Partial resistance of barley to leaf rust, *Puccinia hordei*. IV. Effect of cultivar and development stage on infection frequency. Euphytica 26:249-255.
6. Statler, G.D., and Parlevliet, J.E. 1987. Factors related to partial resistance of barley to leaf rust. Phytopathology 77:549-551.
7. Stavely, J.R. 1984. Pathogenic specialization in *Uromyces phaseoli* in the United States and rust resistance in beans. Plant Dis. 68:95-99.
8. Venette, J.R., and Lamey, H.A. 1986. Dry Edible Bean Diseases. N.D. Extension Circular PP-576 Rev. NDSU Fargo, ND. 8 p.