Reactions of Dry Bean, Lima Bean, and Soybean Cultivars to Rhizoctonia Root and Hypocotyl Rot and Web Blight

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ABSTRACT

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We evaluated the reactions of 15 soybean, 13 dry bean, and two lima bean cultivars to Rhizoctonia root and hypocotyl rot and web blight. Each cultivar was inoculated separately with *Rhizoctonia solani* isolates AG-2-2 and AG-4 to evaluate resistance to root and hypocotyl rot and with a dry bean isolate and a soybean isolate of AG-1 IB to evaluate resistance to web blight. Agar plate, potted plant, detached leaf, and whole plant assays were used to evaluate resistance. Data from agar plate and potted plant assays for hypocotyl and root rot were either not correlated or were only weakly correlated. This indicated that agar plate assays were not satisfactory for determining differences in host resistance and that investigations should be based on potted plant assays. With a few exceptions, all soybean cultivars were resistant or moderately resistant to hypocotyl and root rot in potted plant assays. Of the dry bean and lima bean cultivars tested, only Jackson Wonder was moderately resistant to both diseases. In potted plant assays, hypocotyl and root disease severities were positively correlated for soybean and dry bean ($r = 0.67$ and 0.71, respectively; $P \leq 0.01$). Thus, cultivars may express a similar reaction to both diseases. Soybean cultivars were more resistant to web blight than dry bean cultivars. Web blight ratings from the detached leaf and whole plant assays were correlated for soybean but not for dry or lima bean.

Rhizoctonia root rot and web blight of soybean (*Glycine max* (L.) Merr.), caused by *Rhizoctonia solani* Kühn, have resulted in yield losses as high as 45 and 50%, respectively, in the United States (11,12,27). Crop failure and yield reduction of up to 90% have been attributed to epidemics of web blight on dry bean (*Phaseolus vulgaris* L.) in Costa Rica (28). Rhizoctonia disease has been managed mainly with cultural practices, biological control, and partial protection by fungicides (1,13,28). For the most part, however, these control practices have been ineffective, labor-intensive, and expensive (23,24,28,31).

Considerable research has been devoted to identifying sources of resistance in dry bean (14,21) and to investigating the genetics of resistance in grain legume crops (4,5,19,21,22) and the genetics of pathogenicity in *R. solani* (1,2,16,17). Cultivars resistant to Rhizoctonia root rot have been developed in other crops, such as alfalfa (3), sugar beet (9,10), and cucumber (25). Commercial soybean cultivars with resistance to Rhizoctonia web blight have been developed (18). Selection of resistant germ plasm has been facilitated by the classification of isolates of *R. solani* into anastomosis groups (AGs) of like isolates that exhibit similar pathogenicity and produce similar disease symptoms on certain hosts (1).

The search for resistant cultivars of important crops such as grain legumes remains a challenge to plant pathologists. The objectives of this study were to evaluate selected commercial soybean, dry bean, and lima bean (*P. lunatus* L.) cultivars for resistance to *R. solani* and to evaluate techniques for screening for resistance.

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MATERIALS AND METHODS

Test cultivars. We evaluated 15 soybean, 13 dry bean, and two lima bean cultivars. The reactions of nine of the 15 soybean cultivars to Rhizoctonia web blight were known (18). These cultivars originated from the southern United States and were obtained from B. L. Keeling (U.S. Department of Agriculture, Agricultural Research Service, Louisiana State University). The other six cultivars originated from the Midwest. The dry bean and lima bean cultivars were obtained from Vermont Bean Seed Company (Fair Haven, VT). Dry bean cultivars were chosen to obtain a range of types based on seed morphology. Before they were used, seeds were surface-disinfested in a 0.3% NaClO solution in deionized water for 5 min, rinsed in sterile deionized water, and air-dried.

Test isolates. Four isolates of *R. solani* were selected on the basis of AG, the disease symptoms they caused, and their relative virulence (15). Soybean AG-2-2 isolate 77, originating from a hypocotyl lesion on soybean in Ohio, and dry bean AG-4 isolate 27, originating from a root lesion on dry bean in Zaire, were used to evaluate root and hypocotyl rot reactions. AG-1 IB isolates 43 and 23, obtained from foliar lesions on dry bean and soybean, respectively, in Zaire, were used to evaluate web blight reaction.

Agar plate assay for root rot reaction. Ten seedlings of each cultivar were evaluated on 20 ml of sterile 1.5% water agar in 15-cm-diam petri plates. Seeds were placed in a ring pattern 1 cm from the edge of the plate. The center of each plate was subsequently inoculated with a 13-mm-diam mycelial disk from a 2- to 3-day-old culture of the AG-2-2 or AG-4 isolate on 1.5% water agar. Three to five drops of sterile distilled water were aseptically dispensed onto each seed 2 days later. Plates were sealed with plastic adhesive tape and incubated under continuous darkness for 5 days at 21 ± 2 C. They were then transferred to a bench under 12 hr of fluorescent light (approximately 280 $\mu E \cdot m^{-2} \cdot s^{-1}$) and 12 hr of darkness for four additional days. Nine days after inoculation, seedlings were evaluated for disease severity on a scale from 1 to 5, where 1 = no lesions and normal root length, 2 = localized tissue discoloration without necrosis and near-normal root length, 3 = localized lesions with extensive tissue discoloration and near-normal root length, 4 = nearly complete root necrosis and partially restricted root length, and 5 = complete root rot and severely restricted root length.

Potted plant assay for root and hypocotyl rot reactions. The inoculum layer technique was used for the potted plant assay to evaluate root and hypocotyl rot reactions (24). Ten seeds of each cultivar were planted in a 15-cm-diam plastic pot containing 1 kg of a soil-peat mixture of Wooster silt loam (pH 6.5) and peat (5:1, v/v), 11 g of lime, and 1.9 g of ammonium nitrate. The soil-peat mixture was autoclaved at approximately 116 C for 6 hr before use. Before the seeds were planted, each pot was infested with an intact agar layer from a 2- to

3-day-old culture of the AG-2-2 or AG-4 isolate on 10 ml of 1.5% water agar in a 10-cm-diam petri plate (24). Pots were maintained under 12 hr of incandescent light (approximately 415 $\mu E \cdot m^{-2} \cdot s^{-1}$) at 24 ± 2 C. Pots were watered to saturation after planting and lightly once a day thereafter.

Fourteen days after planting, the seedlings were removed from the soil-peat mixture and their roots were rinsed with water. Seedlings were evaluated for root and hypocotyl rot on scales from 1 to 5. For root rot, 1 = no lesions; 2 = discrete, light or dark brown, superficial necrotic lesions; 3 = adventitious root and/or taproot necrosis and decay; 4 = extensive root rot; and 5 = plant dead. For hypocotyl rot, 1 = no lesions; 2 = discrete, reddish or dark brown, superficial necrotic lesions; 3 = discrete, reddish or dark brown, deep necrotic lesions without stem girdling; 4 = extensive hypocotyl rot with stem girdling; and 5 = plant dead.

Detached leaf assay for leaf blight reaction. Apparently healthy leaves were detached from 21-day-old plants grown in the greenhouse for evaluation of leaf blight reaction. One trifoliate leaf per cultivar was surface-disinfested in a 0.3% NaClO-sterile distilled water solution for 3 sec, then rinsed in two changes of sterile deionized water. Each leaf, with attached leaflets, was placed on a grade 362 filter paper (Baxter Healthcare Corp., McGaw, IL) moistened with sterile distilled water in a 15-cm-diam sterile plastic petri plate.

Each leaflet was inoculated with a 4-mm-diam mycelial disk from a 2- to 3-day-old culture of one of the AG-1 IB isolates on 1.5% water agar. Another leaf was inoculated similarly with the other AG-1 IB isolate in a separate petri plate. Inoculated leaves were given three to four sprays (3–4 ml) of sterile distilled water with a low-pressure, hand-operated atomizer to simulate dew deposition and to increase humidity over the duration of the test. Plates were sealed with Parafilm (American National Can, Greenwich, CT) and maintained for 5 days at 21 ± 2 C with 12 hr of illumination (approximately 280 $\mu E \cdot m^{-2} \cdot s^{-1}$). Leaflets were then evaluated for leaf blight symptoms on a scale from 1 to 5, where 1 = no infection, 2 = 1–25% of leaf area blighted, 3 = 26–50%, 4 = 51–75%, and 5 = 76–100% of leaf area blighted.

Whole plant assay for web blight reaction. Apparently healthy 21-day-old potted plants grown in the greenhouse under conditions described previously were used in whole plant assays for web blight reaction. Plants of each cultivar were inoculated with the dry bean and soybean AG-1 IB isolates in separate pots. One 3- to 4-day-old potato-dextrose agar culture of each of the AG-1 IB isolates was flooded with 20 ml of deionized water and gently and thoroughly scraped. The mycelial suspension was vigorously mixed before the volume was brought up to 40 ml and a drop of Tween 20 was added. Ten plants (five per pot) were sprayed with the mycelial suspension until runoff with a hand-operated, low-pressure atomizer. After inoculation, each pot was maintained in a moistened clear plastic bag in a growth chamber for 48 hr at 100% relative humidity and 25 ± 2 C. Two humidifiers provided a continuous light mist. Plants were exposed to 12 hr of fluorescent and incandescent lights (approximately 280 $\mu E \cdot m^{-2} \cdot s^{-1}$). Five days after inoculation, plants were evaluated on a scale of 1 to 5, where 1 = no infection; 2 = small, discrete, irregular water-soaked and necrotic lesions; 3 = coalescent water-soaked and necrotic lesions, with no mycelial web coverage; 4 = leaf drooping with extensive mycelial web coverage; and 5 = plant dead.

Statistical analysis. For the agar plate and detached leaf assays, the experimental design was a randomized complete block, with a single-plate replication of 10 seedlings for agar plate root rot assays and one trifoliate leaf (three inoculated leaflets per leaf) for detached leaf web blight assays. A split-plot design with isolates as main plots and cultivars as subplots was used for the potted plant and whole plant assays for hypocotyl-root rot and web blight, respectively.

In each assay, individual seedlings, plants, or leaflets were evaluated with the disease severity scales. Treatment means were calculated from the evaluated plant material in each replication (petri plate containing 10 seedlings or three leaflets per treatment, or pot containing five plants per treatment). Each assay was conducted four times, representing four replications over time for analysis of variance. Means were compared with the Fisher least significant difference test at $P = 0.05$. SAS (SAS Institute, Cary, NC) was used for data analysis.

Correlation analysis was used to determine relationships between agar plate and potted plant assays and between detached leaf and whole plant assays. Analyses were performed with Minitab (Minitab Inc., State College, PA).

Resistance response classification. Cultivars were grouped according to dis-

Table 1. Reaction of dry bean and lima bean cultivars to Rhizoctonia root rot in agar plate assays and to root and hypocotyl rot in potted plant assays[u]

	Agar plate assay[w]		Potted plant assay			
Cultivar[v]	Disease severity[x]	Disease reaction[y]	Hypocotyl disease severity[z]	Hypocotyl reaction[y]	Root disease severity[z]	Root reaction[y]
Burpee's lima	...	...	3.3 bcd	MS	2.9 abcd	MR
Fordhook lima	...	...	4.0 ab	MS	3.8 a	MS
Jackson Wonder	4.0 a	MS	2.3 d	MR	2.3 d	MR
Black Turtle	3.4 bc	MS	4.1 a	S	3.8 a	MS
Red Kidney	3.6 abc	MS	3.6 abc	MS	2.6 bcd	MR
Red Mexican	4.0 a	MS	3.9 abc	MS	3.5 ab	MS
Soldier Bean	3.3 c	MS	4.0 ab	MS	3.8 a	MS
White Kidney	3.4 bc	MS	3.6 abc	MS	3.1 abcd	MS
Yellow Eye	3.5 bc	MS	3.6 abc	MS	3.1 abcd	MS
Florida Speckled	3.4 bc	MS	3.9 abc	MS	2.9 abcd	MR
Genuine Cornfield	3.5 bc	MS	3.9 abc	MS	2.3 d	MR
Improved White	4.0 a	MS	3.3 bcd	MS	2.5 cd	MR
Missouri Wonder	3.5 bc	MS	3.5 abcd	MS	3.3 abc	MS
Pinto Bean	4.0 a	MS	3.1 cd	MS	3.3 abc	MS
Great Northern	3.8 ab	MS	3.8 abc	MS	3.5 ab	MS

[u] Data represent pooled means for the AG-2-2 and AG-4 isolates. Means followed by the same letter in a column are not significantly different according to the Fisher least significant difference test ($P = 0.05$).
[v] Cultivars Burpee's and Fordhook are lima beans; all others are dry beans.
[w] Data from agar plate assays of Burpee's and Fordhook are not presented because of low germination in tests.
[x] On a scale from 1 to 5, where 1 = no infection and 5 = complete root rot.
[y] R = resistant, MR = moderately resistant, MS = moderately susceptible, and S = susceptible.
[z] On a scale from 1 to 5, where 1 = no lesions and 5 = plant dead.

ease severity on hypocotyls and/or roots and on leaves. Cultivars were considered resistant if the mean disease score ranged between 1 and 2, moderately resistant if the mean disease score was 2.1–3, moderately susceptible if the mean disease score was 3.1–4, and susceptible if the mean disease score was 4.1–5.

RESULTS

Agar plate assay for root rot reaction. Roots of diseased seedlings of both dry bean and soybean were similar in length to those of control seedlings but exhibited extensive necrosis. Disease severity ratings ranged from 3.3 to 4.0 for cultivars of both hosts (Tables 1 and 2). Soldier Bean had the lowest disease rating of the dry bean and lima bean cultivars tested, and Centennial, Davis, Ripley, and Vickery had the lowest disease ratings of the soybean cultivars tested. Although statistically significant differences were detected among cultivars in disease ratings, all cultivars of dry bean and soybean were rated as moderately susceptible to root rot in agar plate assays. Burpee's and Fordhook lima beans did not develop disease symptoms and were excluded from the data analysis. These large-seeded cultivars did not fully germinate on water agar, presumably because of limited water availability.

Potted plant assay for hypocotyl and root rot reactions. Five of 13 dry bean cultivars and one of the two lima bean cultivars were moderately resistant to root rot, with disease severity ratings between 2.3 and 2.9 (Table 1). Jackson Wonder was the only dry bean cultivar with relatively low disease ratings for both hypocotyl and root rot.

The soybean cultivars were generally less susceptible to hypocotyl and/or root rot than the dry bean cultivars. Ten of the 15 soybean cultivars were moderately resistant to hypocotyl rot, with disease severity ratings between 2.3 and 3.0 (Table 2). Asgrow 7986, Centennial, Hardee, Pella, RA 606, and Vickery were rated as resistant to root rot and moderately resistant to hypocotyl rot.

The cultivar-by-isolate interaction was significant ($P = 0.05$) for root rot severity on dry bean but not on soybean. The interaction was due to one dry bean cultivar, Improved White, that had significantly more severe root rot with the AG-4 isolate (mean disease score 3.3) than with the AG-2-2 isolate (mean disease score 1.8). No statistical difference between isolates in root rot severity was observed on other cultivars.

Detached leaf assay for web blight reaction. By 5 days after inoculation, differences in the percentage of leaf area with lesions were evident among the cultivars tested. Leaves of all dry bean and lima bean cultivars were extensively blighted (Table 3). Among soybean cultivars, Bedford, Gregg, and RA 606 were moderately resistant, Davis exhibited the most severe web blight, and all others were moderately susceptible (Table 3).

Whole plant assay for web blight reaction. Six of 13 dry bean cultivars and both lima bean cultivars were moderately susceptible to web blight; Soldier Bean had the lowest severity rating (3.3). The remaining cultivars were susceptible (Table 4).

Soybean cultivars Bedford, Centennial, Gregg, Pioneer 9581, RA 606, Conrad, Edison, Ripley, and Vickery were moderately resistant to foliar infection. The other six cultivars were moderately susceptible (Table 4).

A significant ($P = 0.05$) cultivar-by-isolate interaction was observed for web blight severity on dry bean in whole plant assays. Cultivars Jackson Wonder and Improved White had significantly ($P \leq 0.05$) more severe web blight when they were inoculated with the dry bean AG-1 IB isolate (mean disease score 5.0) than with the soybean AG-1 IB isolate (mean disease score 3.8). No statistical difference between isolates was observed on other dry bean or lima bean cultivars. Similarly, the AG-1 IB isolates did not differ significantly on soybean cultivars.

Correlations among assays. In potted plant assays, the severity of hypocotyl rot was positively correlated with the severity of root rot for both dry bean and soybean ($r = 0.71$ and 0.67, respectively; $P \leq 0.01$). The correlation between agar plate and potted plant assays was low for both root rot ($r = -0.23$) and hypocotyl rot ($r = -0.21$) and was not significant ($P > 0.05$). Web blight ratings from detached leaf and whole plant assays were significantly correlated for soybean ($r = 0.71$, $P \leq 0.01$) but not for dry bean ($r = 0.15$, $P \geq 0.05$).

DISCUSSION

The soybean, dry bean, and lima bean cultivars tested expressed a range of resistance-susceptibility responses to infection by isolates of *R. solani* representing three AGs. Dry bean cultivars were generally only moderately resistant to root rot except for Jackson Wonder, which appeared to be resistant to both root rot and hypocotyl rot. In contrast, most soybean cultivars (except Edison, Ripley, and Williams) were moderately resistant or resistant to both hypocotyl rot and root rot. In detached leaf assays for web blight reaction, all dry bean and lima bean cultivars were susceptible, whereas most soybean cultivars were moderately susceptible or moderately resistant. In whole plant assays, all dry and lima bean cultivars were moderately susceptible or susceptible to web blight,

Table 2. Reaction of soybean cultivars to Rhizoctonia root and hypocotyl rot in agar plate and potted plant assays[w]

Cultivar	Agar plate assay		Potted plant assay			
	Root rot severity[x]	Root reaction[y]	Hypocotyl rot severity[z]	Hypocotyl reaction[y]	Root rot severity[z]	Root reaction[y]
Asgrow 7986	3.6 abc	MS	2.8 b	MR	1.8 bc	R
Bedford	3.6 abc	MS	3.4 ab	MS	2.4 ab	MS
Centennial	3.4 c	MS	3.0 b	MR	1.9 bc	R
Davis	3.4 c	MS	3.8 a	MS	2.6 a	MR
FFR 646	3.6 abc	MS	3.3 ab	MS	2.1 abc	MR
Gregg	3.8 abc	MS	3.1 ab	MS	2.3 abc	MR
Hardee	3.9 ab	MS	2.9 b	MR	2.0 abc	R
Pioneer 9581	3.9 ab	MS	2.3 ab	MR	2.1 abc	MR
RA 606	3.5 bc	MS	2.9 b	MR	2.0 abc	R
Conrad	4.0 a	MS	3.4 ab	MS	2.3 abc	MR
Edison	4.0 a	MS	2.8 b	MR	2.3 abc	MR
Pella	3.6 abc	MS	2.8 b	MR	1.6 c	R
Ripley	3.4 c	MS	2.8 b	MR	2.1 abc	MR
Vickery	3.4 c	MS	3.0 b	MR	1.9 bc	R
Williams	3.6 abc	MS	2.8 b	MR	2.1 abc	MR

[w] Data represent pooled means for the AG-2-2 and AG-4 isolates. Means followed by the same letter in a column are not significantly different according to the Fisher least significant difference test ($P = 0.05$).
[x] On a scale from 1 to 5, where 1 = no lesions and 5 = complete root rot.
[y] R = resistant, MR = moderately resistant, MS = moderately susceptible, and S = susceptible.
[z] On a scale from 1 to 5, where 1 = no lesions and 5 = plant dead.

while nine of 15 soybean cultivars were moderately resistant. Although only a limited number of cultivars were evaluated, the results reported here suggest that the probability of selecting cultivars with resistance to diseases caused by *R. solani* is higher within *G. max* than within *P. vulgaris* or *P. lunatus*.

In *P. vulgaris,* resistance to Rhizoctonia seed rot has been associated with cultivars that have dark seed coats (14). Prasad and Weigle (20) suggested that black seed coats may restrict pathogen entry because they adhere more tightly to cotyledons and tend to crack less than lighter seed coats. Hypocotyl infection and postemergence damping-off have been linked with aging, woodiness, and purple pigments (4,14). Secondary metabolites including phytoalexins have been reported as postinfection resistance factors in dark-seeded dry bean (20,21). However, none of the dry bean cultivars with colored seeds that we tested, including the black-seeded Black Turtle, was resistant to either preemergence damping-off or hypocotyl rot. Hypocotyl rot and damping-off were even more severe on Black Turtle with purple hypocotyls than on the moderately resistant, white-seeded Jackson Wonder. These results suggest that dark pigments may not be linked with resistance to *R. solani* in dry bean.

Preexisting morphological factors that confer resistance to *R. solani* have not been documented as well in soybean as in dry bean. Increased phytoalexin production in younger plants (0–2 wk old) and stem woodiness with aging have been reported as possible resistance mechanisms to Phytophthora stem rot (caused by *Phytophthora sojae*) of soybean (19). The hardness of the soybean seed coat relative to dry bean seeds and phytoalexin accumulation may explain the greater resistance of the soybean cultivars we tested compared to the dry bean cultivars.

Differences in cultivar response to web blight have previously been reported in dry bean (8) and soybean (18). However, information on the mechanism of resistance is limited. It has been demonstrated that unidentified inhibitory substances of host origin can arrest infection cushion formation on radish, tomato, and lettuce (6,7). Phytoalexin production and infection cushion inhibitors could be involved in resistance in both dry bean and soybean to isolates that cause web blight.

Discrepancies between field results and laboratory and growth chamber assays may be attributed to experimental conditions. Conflicting results have been reported in tests that used either low (29) or high (26) levels of inoculum for screening dry bean cultivars. In field evaluations in Louisiana, soybean cultivars Gregg, Centennial, Hardee, and RA 606 were resistant and Davis and FFR 646 were susceptible to web blight (18). Another study (30) reported that Jackson Wonder dry bean was resistant to root and hypocotyl rot. These cultivars had similar disease reactions in our assays, although the differences among them were not always statistically significant. This indicates that the techniques we used have some degree of reliability and may be useful in separating resistant germ plasm from more susceptible lines.

Agar plate assays may not be adequate for determining cultivar reactions to root rot, because the results were not highly correlated with those of potted plant assays. Cultivar responses may differ because of differences in the infection processes for seedlings germinating on agar colonized by the fungus and for roots and hypocotyls contacting inoculum in a soil-peat mix.

The web blight severity ratings from detached leaf and whole plant assays were significantly correlated for soybean but not for dry and lima bean cultivars. In both assays, most dry and lima bean cultivars were more susceptible to web blight than were the soybean cultivars. The difference between the two assays may have resulted from the greater susceptibility of the dry and lima bean cultivars compared to the soybean cultivars in the detached leaf assay, in contrast to the whole plant assays, in which both dry bean and soybean expressed a higher level of resistance.

In whole plant assays, root disease severity was correlated with hypocotyl disease severity. This suggests that a cultivar that is resistant to one disease may be resistant to the other and that screening tests may be designed to evaluate reaction to one disease only. Despite these results, we believe that agar plate assays should not replace potted plant assays

Table 3. Reaction of lima bean, dry bean, and soybean cultivars to Rhizoctonia web blight in detached leaf assays[x]

Bean cultivar	Web blight severity[y]	Web blight reaction[z]	Soyean cultivar	Web blight severity[y]	Web blight reaction[z]
Burpee's lima	5.0 a	S	Asgrow 7986	3.3 abc	MS
Fordhook lima	5.0 a	S	Bedford	2.9 bc	MR
Jackson Wonder	4.9 a	S	Centennial	3.3 abc	MS
Black Turtle	5.0 a	S	Davis	4.1 a	S
Red Kidney	5.0 a	S	FFR 646	3.1 abc	MS
Red Mexican	5.0 a	S	Gregg	2.3 c	MR
Soldier Bean	5.0 a	S	Hardee	3.4 abc	MS
White Kidney	5.0 a	S	Pioneer 9581	3.1 abc	MS
Yellow Eye	5.0 a	S	RA 606	2.4 c	MR
Florida Speckled	4.5 b	S	Conrad	3.4 abc	MS
Genuine Cornfield	5.0 a	S	Edison	3.3 abc	MS
Improved White	5.0 a	S	Pella	3.9 ab	MS
Missouri Wonder	5.0 a	S	Ripley	3.3 abc	MS
Pinto Bean	5.0 a	S	Vickery	3.4 abc	MS
Great Northern	5.0 a	S	Williams	4.0 ab	MS

[x] Data represent pooled means for two AG-1 IB isolates, one each from soybean and dry bean. Means followed by the same letter in a column are not significantly different according to the Fisher least significant difference test ($P = 0.05$).
[y] On a scale from 1 to 5, where 1 = no lesions and 5 = 76–1000% of leaf area blighted.
[z] S = susceptible, MS = moderately susceptible, and MR = moderately resistant.

Table 4. Reaction of lima bean, dry bean, and soybean cultivars to Rhizoctonia web blight in whole plant assays[x]

Bean cultivar	Web blight severity[y]	Web blight reaction[z]	Soyean cultivar	Web blight severity[y]	Web blight reaction[z]
Burpee's lima	3.8 defg	MS	Asgrow 7986	3.1 abc	MS
Fordhook lima	3.6 efg	MS	Bedford	2.5 de	MR
Jackson Wonder	3.4 fg	MS	Centennial	2.9 abcde	MR
Black Turtle	4.0 cde	MS	Davis	3.1 abc	MS
Red Kidney	3.4 fg	S	FFR 646	2.9 abcde	MS
Red Mexican	4.1 cde	S	Gregg	2.4 e	MR
Soldier Bean	3.3 g	MS	Hardee	3.3 ab	MS
White Kidney	3.4 fg	MS	Pioneer 9581	2.8 bcde	MR
Yellow Eye	3.9 cdef	MS	RA 606	2.9 abcde	MR
Florida Speckled	3.8 defg	MS	Conrad	3.0 abcd	MR
Genuine Cornfield	4.9 a	S	Edison	2.8 bcde	MR
Improved White	4.4 abc	S	Pella	3.4 a	MS
Missouri Wonder	4.4 abc	S	Ripley	3.0 abcd	MR
Pinto Bean	4.3 bcd	S	Vickery	2.6 cde	MR
Great Northern	4.8 ab	S	Williams	3.3 ab	MS

[x] Data represent pooled means for two AG-1 IB isolates, one each from soybean and dry bean. Means followed by the same letter in a column are not significantly different according to the Fisher least significant difference test ($P = 0.05$).
[y] On a scale from 1 to 5, where 1 = no lesions and 5 = plant dead.
[z] S = susceptible, MS = moderately susceptible, and MR = moderately resistant.

for evaluating cultivar resistance and that assays should evaluate both hypocotyl and root reaction until additional supporting data are available.

Our results indicate that there is potential for selecting soybean and bean cultivars resistant to *R. solani.* Soybean cultivars Asgrow 7986, Centennial, Hardee, RA 606, Pella, and Vickery and dry bean cultivar Jackson Wonder may represent sources of resistance to root and hypocotyl rot. The use of different isolates of *R. solani,* inoculum types, and inoculation techniques in screening germ plasm for resistance has led to difficulties in comparing results and identifying useful sources of resistance in both crops. Identification of isolates by AG and use of standard assay techniques will be important in future research.

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