Root rot of pea caused by *Rhizoctonia solani* AG-8: Yield loss and screening for resistance

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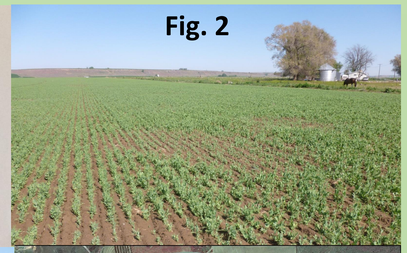
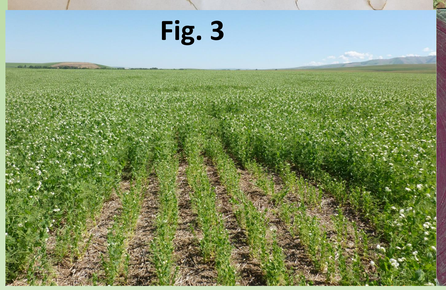
Abstract

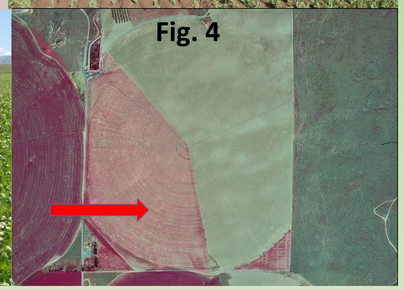
Stunting of pea caused by *Rhizoctonia spp.* is an important root disease of pea crops in the Columbia Basin of Oregon and Washington States. The disease is most severe in fields where cereal cover crops are incorporated into the soil just prior to planting pea seed. *Rhizoctonia* spp. colonize the dying cereal roots and then infect the roots of pea seedlings. A survey was conducted in a field of severely stunted peas near Basin City, WA. Ten patches of stunted pea plants were flagged in the first week of June. Manual harvest of peas was done inside each flagged patch (1 m^2) a month later. Harvest also was done from an adjacent healthy area next to each patch to estimate yield loss from stunting. Stunted patches in the pea field incurred a 75% yield loss compared to adjacent healthy areas. A set of 32 pea lines/cultivars was inoculated with *R. solani* AG-8 to identify lines/cultivars with tolerance or resistance to the pathogen, using a randomized complete block design under greenhouse conditions. Plant height and root rot severity (1 to 9 scale) were evaluated four weeks after inoculation. The reduction in plant height caused by *R. solani* AG-8 averaged 35 ± 12% and ranged from 4 to 59% compared to non-inoculated control plants of the 32 cultivars. The cultivar Franklin had the least reduction (4%) in plant height followed by Bohatyr (16%), Spectes (21%), Carousel (22%), Aragorn and Universal (24%), and Toledo and Marjoret (25%). Root rot severity rating averaged 6 ± 0.88 and ranged from 4 to 7. The least severe root rot (4) was observed on Aragorn, Columbian, Franklin, and Melrose. These findings show the importance of stunting of pea caused by *R. solani* AG-8, and identify pea lines with potential tolerance or resistance to the pathogen.

Introduction

Farmers in the Pacific Northwest sometimes lose a percentage of their crops to the soilborne fungal pathogen *Rhizoctonia*. Because of the ecology of the fungus and growers' practices, *Rhizoctonia* can be difficult to manage. Currently, there are limited effective fungicides, biocontrol agents, disease resistant varieties, or other cost effective means of combating this pathogen in pea crops. Some aspects of the disease that scientists at Washington State University (WSU) and the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) have been working on include: determining economic losses to pea stunting, characterizing *Rhizoctonia* spp. from stunted pea plants, testing pathogenicity of *Rhizoctonia* isolates of different AGs, testing the timing of herbicide spray to the cover crop, and screening for disease resistance/tolerance. As part of my internship in summer 2013, I participated in research determining yield loss caused by *Rhizoctonia*, and greenhouse experiments screening for pea lines resistant/tolerant to *Rhizoctonia.*







Materials and Methods

A survey was conducted in 2013 in a pea field with numerous patches of severely stunted plants near Basin City, WA. Ten patches of stunted plants were flagged the first week of June. Manual harvest of peas was done inside each flagged patch (from 1 m^2) a month later. Pea harvest also was done (1 m^2) from an adjacent healthy area next to each patch to estimate yield loss from stunting. The healthy area was within 3-5 meters of the patch to reflect the same soil conditions, fertility, irrigation, microclimate, etc. The peas were then dried, shelled, cleaned, and weighed (g) to compare yield from the healthy area vs. the patch.

A set of 32 pea lines/cultivars was inoculated with *R. solani* AG-8 to screen for potential tolerance or resistance to the pathogen, using a randomized complete block design under greenhouse conditions. Oat seed was inoculated with *R. solani* AG-8, dried, ground and sieved to a size of 0.25 to 1.00 mm. The inoculum was then mixed evenly into soil at 1% (w/w), and pea seeds of the various lines planted into the soil. Plant height, shoot weight, root weight, total weight, and root rot severity (1 to 9 scale) were evaluated four weeks after inoculation, and compared to the same variables measured for non-inoculated pea plants of each cultivar/line.

Results

Yield loss trial: A paired t-test revealed a significant difference in mean pea yield harvested within 10 patches compared to pea yield outside the patches (P <0.001) in the growers' field. Patches in the pea field incurred a 75% yield loss compared to adjacent healthy areas.

Resistance screening: The reduction in plant height caused by *R. solani* AG-8 averaged 35 ± 12% and ranged from 4 to 59% for inoculated vs. non-inoculated plants of the 32 pea cultivars. The cultivar Franklin had the least reduction (4%) in plant height, followed by Bohatyr (16%), Spectes (21%), Carousel (22%), Aragorn and Universal (24%), and Toledo and Marjoret (25%). Root rot severity rating averaged 6.00 ± 0.88 and ranged from 4.00 to 7.00. The least severe root rot (4) was observed for Aragorn, Columbian, Franklin, and Melrose.

Table 1.	Pea grain weight (g/m^2)	
Patch No.	Inside patch	Outside patch
1	87.0	561.0
2	153.2	488.9
3	116.2	543.3
4	67.2	442.2
5	95.0	484.0
6	108.0	569.9
7	208.2	496.5
8	106.5	491.1
9	77.3	520.0
10	249.4	542.0
Mean	126.8	513.9
	Yield loss(%)	**75.3**
	T-test (*P*-value)	**<0.0001**

Fig. 1. Pea plants showing the effects of *Rhizoctonia* (right) compared to healthy plants (left). **Fig. 2.** Early stage of growth of a pea crop (May 2013) showing patches caused by *Rhizoctonia* spp. in a field near Basin City, WA. **Fig. 3.** Advanced infection showing severe stunting in a distinct patch (June 2013). **Fig. 4.** Aerial image of the pea field with stunted patches. The light red area is the pea crop. The small, pale spots are patches of stunted plants. **Fig. 5.** Pea plants harvested from outside (left bag) vs. inside (right bag) a patch of stunted plants on 4 July 2013. **Table 1.** Pea yields from inside vs. outside stunted patches of pea plants caused by *Rhizoctonia*.

SN	Pea Cultivar/Line	% Reduction in Plant Height	% Reduction in Shoot weight	% Reduction in root weight	% Reduction in total weight	Root Rot Rating
1	847-28 PI660732	41 a-f	48 a-h	55 ab	51 ab	6 b-e
2	847-22 PI660731	56 a-c	61 ab	65 ab	63 a	7 ab
3	846-07 PI660729	32 d-h	41 a-i	36 a-c	39 a-e	5 c-e
4	90-2079	52 a-c	52 a-e	56 ab	53 ab	6 a-d
5	Lifter	33 d-f	18 d-i	44 a-c	29 a-g	6 c-e
6	Windham	43 a-f	54 a-d	30 a-c	47 a-c	6 a-d
7	Puget	34 c-f	33 a-i	45 a-c	38 a-d	6 b-e
8	Medora	44 a-f	53 a-d	38 a-c	49 a-c	8 a
9	Delta	45 a-e	49 a-f	7 a-e	40 a-e	5 c-e
10	Admiral	38 a-f	22 c-i	34 a-c	26 a-e	6 b-d
11	Ariel	40 a-f	51 a-f	28 a-d	44 a-c	6 c-d
12	Bonner	36 b-f	53 a-d	39 a-c	50 b-c	6 a-d
13	Guido	52 a-d	66 ab	56 ab	64 a	7 a-c
14	Columbian	32 d-h	32 a-i	9 a-e	25 a-e	4 ef
15	Granger	32 d-h	19 d-i	44 ef	3 d-g	5 c-f
16	Alaska 81	30 d-h	19 d-l	71 f	-5 fg	5 c-e
17	Universal	24 e-i	12 f-l	38 ef	-1 e-g	5 c-f
18	Toledo	25 e-i	3 l	83 f	-14 g	5 d-f
19	Monarch	36 b-h	26 b-l	10 a-e	23 a-e	6 a-d
20	Aragorn	24 e-i	13 e-l	38 ef	0 e-g	4 ef
21	Bohatyr	16 hi	35 a-l	41 a-c	37 a-f	5 c-e
22	Carousel	22 f-i	6 l	13 a-e	8 c-g	6 b-e
23	Spectes	21 f-i	32 a-l	25 a-d	30 a-f	5 c-f
24	Melrose	34 c-h	13 e-l	6 a-e	10 b-g	4 ef
25	Spector	58 ab	68 a	54 ab	64 a	7 a-c
26	Prodigy	46 a-e	50 a-g	39 a-c	46 a-c	7 a-c
27	Stirling	34 c-h	31 a-l	4 b-e	23 a-g	5 d-f
28	Franklin	4 i	32 a-l	42 a-c	35 a-f	4 f
29	Cruiser	38 a-h	33 a-l	-8 c-e	22 a-g	5 c-e
30	Marjoret	25 e-i	10 hi	-31 d-f	-3 e-g	6 a-d
31	Midas	59 a	60 a-c	54 ab	58 a	5 c-e
32	Banner	41 a-g	47a-h	40 a-c	45 a-d	5 c-e

Table 2. Screening of pea lines for resistance to root rot caused by *Rhizoctonia solani* AG-8. Five replications were tested per line/cultivar. Analysis of variance was calculated, with Fisher's protected least significant difference (LSD at P = 0.05) for means separation. Means followed by the same letter within a column indicates no significant differences among those lines/cultivars. Rows highlighted in yellow show the most promising potential for disease resistance or tolerance to *R. solani* AG-8.

Conclusions

- Peas are a very important crop in the Pacific Northwest, where >105,000 acres are grown annually.
- Yield loss within stunted patches averaged 75% in a growers' pea seed crop in 2013.
- Screening of pea lines/cultivars identified a few with promising resistance or tolerance to *R. solani* AG-8.
- The potential resistance/tolerance should be evaluated further under field conditions.

Acknowledgements

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