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Powdery Scab: Management Tactics and the Effect of Root Galls on Potato Yields

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Powdery scab is a major concern for potato production in the Columbia Basin of central Washington and north central Oregon. Occurrence of powdery scab in the Columbia Basin before 1981 was light and sporadic, whereas currently, the disease occurs at high severities in many fields through out the region. Infected seed tubers and contaminated soils are means of disseminating the fungus-like protozoan that causes powdery scab, *Spongospora subterranea* f. sp. *subterranea*. This fungus-like protozoan also transmits the virus (PMTV) that causes potato mop top.

Potato roots, stolons and tubers are infected early in the growing season when soils are relatively cool in the Columbia Basin. Irrigation water supplies the wet soils needed for infection. Symptoms however, do not develop for three or more weeks after infection. The powdery scab organism synergistically interacts with *Colletotrichum coccodes*, the cause of potato black dot, to produce more severe disease and plant damage. The powdery scab organism persists in soil for eight or more years.

Symptoms - Symptoms of powdery scab are confined to belowground plant organs. Infected roots and stolons develop wart-like galls. These are white at first and turn brown as they mature. Galls vary in size up to that of a pea. Symptoms on young tubers consist of small, gray, elevated areas (pustules) on the tuber surface. Pustules later dry and break open, leaving circular to oval, small, scabby pits. The pits contain a brownish powder that consists of a mass of spores. Pustules on tubers can be entry points for infection by the pink rot, Pythium leak, and late blight pathogens.

The potato mop top virus causes raised rings on the tuber surface and necrotic dark brown arcs in the tuber flesh, which resemble corky ring spot (tobacco rattle virus) symptoms. The necrotic arcs caused by PMTV in tubers are especially severe in cool weather potato production regions. Symptoms on foliage consist of stunting of stems and shortening of internodes on some or all of the stems of infected plants. Bright yellow blotches, rings, and V-shaped yellow marking occur on leaflets.

Resistance - Resistance offers a potential of reducing the effects of powdery scab. Tubers of most white cultivars such as Shepody and red cultivars are susceptible to infection and develop numerous pustules. Whereas, tubers of russet skin cultivars such as Russet Burbank, Ranger Russet, Umatilla Russet and Alturas usually do not develop noticeable tuber lesions. Roots of most cultivars

grown in the Columbia Basin are susceptible and can be come severely infected when grown on infested ground. However, potato lines resistant to root galling have been identified in test plots in the Columbia Basin. Evaluation began in 2003 by Chuck Brown, Dennis Johnson, Dallas Batchelor and Chris Olsen and has led to the identification of resistance in breeding material used in the Pacific Northwest (2,3). Resistance to root galling is now being incorporated into commercially acceptable cultivars. Cultivars with resistance to root galling have also been developed in Colorado. Cultivars with resistance to root galling include Summit Russet, Mesa Russet, Rio Grande Russet and Owyhee Russet. We will be evaluating Sage Russet and Alturas for resistance this summer.

A possible advantage of growing cultivars with resistance to root galling is that fewer resting spores should be returned to the soil at the end of the season and consequently, less inoculum would affect future potato crops. Control of weeds as reproduction hosts would be important during the rotation period. In contrast, growing susceptible cultivars or not managing weed hosts (nightshades) during the rotation period would increase inoculum levels for future potato crops. We are presently quantifying the effects of resistance on subsequent inoculum levels in the Columbia Basin.

Management - Effective control practices are not currently available for reducing powdery scab galls on roots and stolons of potato cultivars once the fungus has been introduced into a field or soil. The fungus needs to be kept out of fields and areas where it is not currently present. Management of powdery scab consists of planting disease-free seed tubers, avoiding planting on land contaminated with the scab fungus, avoid applying manure from animals fed infected tubers, controlling weeds in the potato family (nightshade), and avoiding moving contaminated soil on equipment or irrigation water to clean fields. Effective chemical control of powdery scab galls will likely require either a systemic fungicide that moves systemically to new root growth or an application method that will distribute an effective material in the root zone of the soil. Neither a systemic fungicide nor thorough soil application method are currently available.

Omega has activity against the powdery scab organism and registration is being sought in Washington State. In-furrow application has suppressed disease levels in some trials. However, the fungicide needs to be distributed through as much of the planting furrow as possible. Nozzles delivering material before and after the seed piece have been most effect. Cost of the material is high, and the costs relative to expected benefits need to be considered before application. This is especially pertinent with the finding reported below that moderate numbers of galls on Umatilla Russet do not reduce plant yields.

Cool (50 to 55 F), moist soils favor infection and development of powdery scab. In a previous study in the Columbia Basin (1), fields planted after mid April had significantly fewer infected plants than those planted earlier. Soil temperature usually increase in early May, so late planted crops are grown in cool soil for a shorter time, giving the powdery scab organism less time to infect and develop. Soil temperatures above 60 F retard the development of powdery scab.

Effect of root galls on tuber yield - Root galls are not associated with any apparent above ground plant symptoms and it is not known if yields are appreciably reduced by the galls. An experiment was conducted in the field in 2010 to determine the effect of galls on potato yield. In that experiment, Mesa Russet, which is resistant to root galls of powdery scab and Umatilla Russet, which is susceptible were planted in soil infested and not infested with the powdery scab fungus. The infested soil was in a commercial field near Warden and the non-infested soil was at the Othello Research Station. Yields of the resistant and susceptible cultivars grown in infested and non-infested were compared to determine the effect of the galls on yield. Cultivars were arranged in a randomized

complete block design with ten replicates at each location. Plots were six plant rows; roots of three plants were carefully dug to quantify galls and three plants were harvested for yield. A root gall index of 1 to 4 was used to quantify root galling (Table1). Yield ratios derived from the following formula for each cultivar were used to evaluate effect of powdery scab on yield: yield of diseased (infested soil)/ yield of non-disease (non-infested soil). A yield ratio of 1.00 or higher for Umatilla Russet would indicate that powdery scab galls had little effect on yield.

Results of the experiment showed that incidence of root systems with galls and severity of galling was significantly less for Mesa Russet than for Umatilla Russet (Table 2). Yields were higher for Umatilla Russet than for Mesa Russet at both locations (Table 3). Yield ratios for total yield and mean tuber weight were 1.00 or higher for Umatilla (susceptible cultivar), indicating that powdery scab had no effect on these yield components (total yield and mean tuber weight) at the level of galls encountered (about 50 per root system). Yield ratio for tuber number for Umatilla was 0.82. Yield ratios for total yield and number of tubers did not differ for the two cultivars. Yield ratio for mean tuber weight was less for Mesa than for Umatilla but both values were near or greater than 1.00 (Table 3). Total yield and tuber number did not change significantly as gall index increased for both cultivars (Fig. 1). However, mean tuber weight significantly increased as gall index increased for Umatilla Russet ($P = 0.016$), indicating that a moderate amount of the disease had a positive effect on this yield component.

The experiment is being repeated in 2011. Preliminary findings indicate that moderate numbers of galls on roots of Umatilla Russet (about 50 per root system) have no negative effect on plant yield. Resistance needs to be coupled with desired agronomic traits and yield. Cultivars may react differentially to root galls with respect to plant yield and the susceptibility/resistance and yield response of cultivars grown in the Pacific Northwest need to be determined. Improved cultivars with resistance to root galling will yield well and should reduce disease pressure for future potato crops by reducing inoculum levels in the soil.

Literature Cited

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2. Nitzan, N., Cummings, T.F., Johnson, D.A., Miller, J.S., Batchelor, D.L., Olsen, C., Quick, R.A., and brown, C.R. 2008. Resistance to root galling caused by the powdery scab pathogen Spongospora subterranean in potato. Plant Dis. 92:1643-1649.

3. Nitzan, N., Haynes, K.G., Miller, J.S., Johnson, D.A., Cummings, T.F., Batchelor, D.L., Olsen, C., and Brown, C.R. 2010. Genetic stability in potato germplasm for resistance to root galling caused by the powdery scab pathogen, Spongospora subterranean. Amer. J. Potato Res. 87:497-501.

Table 1. Powdery scab index used to quantify number of galls on root systems.

Powdery Scab Index	
Index	No. Galls/root system
0	0
1	1-25
2	25-50
3	50-100
4	100-150

Table 2. Mean incidence of root systems with galls and mean root gall index for plants of Mesa Russet and Umatilla Russet grown on a sandy loam soil infested with the powdery scab organism.

Cultivar	Incidence of roots systems with galls (%)	Root gall index
Mesa Russet	41*	0.46*
Umatilla Russet	100	1.83

* = Significantly less than Umatilla Russet at $P < 0.01$

Table 3. Yield and yield ratio of Mesa Russet (resistant to root galling) and Umatilla Russet (susceptible to galling) grown on a sandy loam soil infested with the powdery scab organism near Warden and on a silt loam soil not infested at Othello.

Cultivar	Total Yield (g)	Tuber Number	Mean tuber weight (g)
Infested soil			
Mesa Russet	6583.2 a	21.2 a	310.3 a
Umatilla Russet	8430.3 b	35.9 b	238.4 b
Non-infested soil			
Mesa Russet	7199.9 a	23.1 a	321.1 a
Umatilla Russet	8410.1 b	44.1 b	192.8 b
Yield Ratio[a]			
Mesa Russet	0.91	0.92	0.97
Umatilla Russet	1.00	0.82	1.23*

[a]Yield ratio = yield of diseased (infested soil)/ yield of non-disease (non-infested soil).

- = Ratio significantly greater than for Mesa Russet at $P = 0.02$

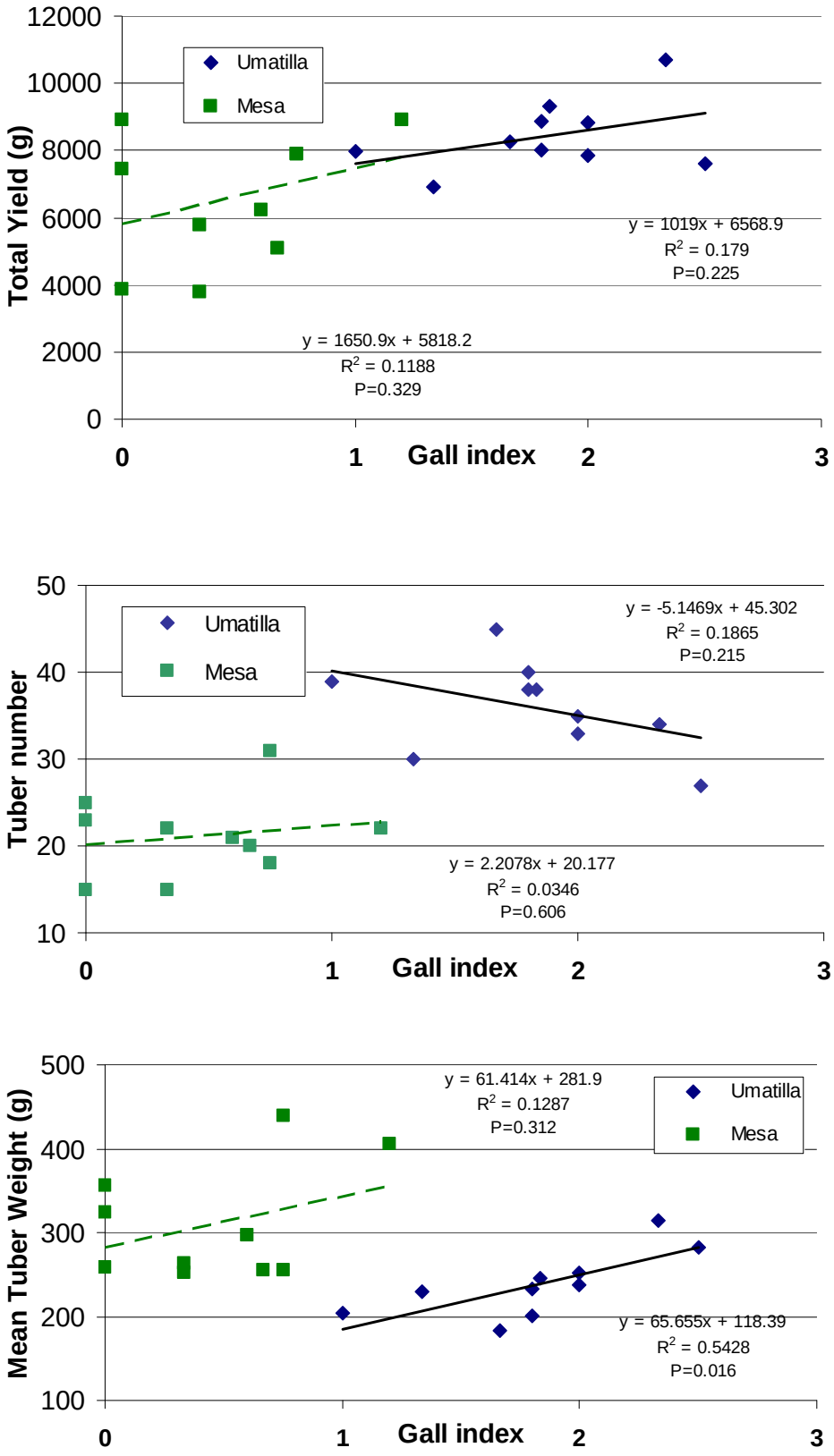

Figure 1. Relationship of yield components with root gall index for Umatilla and Mesa Russet potatoes

Mark Your Calendars

WSU Potato Field Day – June 23, 8:30 am – 1 pm, Othello Research Unit, Hosted lunch. Contact: Mark Pavek, 509-335-6861, mjpavek@wsu.edu.

****Note the field day is on Thursday this year!****

OSU Potato Field Day – June 22, 8:00 am, OSU Hermiston. Contact: http://oregonstate.edu/dept/hermiston/

WSU Late Blight Information Line, May 23, 2011

Late blight has not been report in the Columbia Basin at this time. We have chased down a few false rumors, but that's what they were. Weather the next 14 days is projected to be cooler and wetter than normal. This will favor late blight. Late blight pressure is higher this year than previous years and we are recommending that fungicide applications begin earlier. An application should go on 7 to 10 days before projected row closure, and then every seven days until mid July or until notified. Chlorothalonil or an EBDC such as mancozeb are good choices at this time. Major rainy periods are projected to be May 25-28, June 1-3 and June 7. Fields close to row closure or beyond should be protected before major rainy periods.

Please contact Dennis Johnson when you find or suspect any late blight. We had a shift in races the last two years with the A1 mating type moving in and we need to monitor the race situation.

Additional management practices:

1. Restrict irrigation until the crop is fully emerged.

2. Do not irrigate potatoes within 80 ft of the pivot center. This is usually the wettest area of the circle and most conducive environment for late blight and tuber rots. Infected plants near the pivot center are often a source of additional infections through out the circle. Lost production area is about 0.3 acre (with 20 ft. radius subtracted for pivot road).

3. Design irrigation systems to avoid irrigation overlaps.

4. Eliminate culls and tuber refuse.

5. Eliminate volunteer potato plants, especially in fields that had late bight in them last year or the year before. Volunteers in these fields run a high risk of being infected and a source of infection the current season.

Contact Dennis Johnson at 509-335-3753 to confirm or to make late blight diagnosis, and get further updates by calling 800-984-7400.