EFFECTS OF MECHANICAL PLANT DESTRUCTION AND CHEMICAL VINE KILLING ON POTATO TUBER BLACK SCURF CAUSED BY RHIZOCTONIA SOLANI

by
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Rhizoctonia solani is a poorly controlled potato pathogen affecting underground potato plant parts. It is widespread, and has been important throughout North America for over 50 years (Rowe, 1993). Currently, the only controls are 1) cultural practices favoring rapid emergence, 2) crop rotation to allow plant residues (especially potato, sugar beet, alfalfa and clover residues) to decompose before planting, and 3) use of seed tubers free of Rhizoctonia sclerotia.

The importance of tuberborne sclerotia in initiating plant infections, once was controversial, but now it is known that scurf provides a major source of inoculum for plants infected with Rhizoctonia anastomosis group, AG-3, the primary potato Rhizoctonia. AG-3 declines rapidly in soil in the absence of potato and depends upon its intimate association with tubers for survival. Our work in western Washington and recent work done by Banville (1989) and Carling (1989) also demonstrates that tuberborne Rhizoctonia inoculum can result in plant damage and loss of yield. New ways of managing the Rhizoctonia black scurf problem are needed.

We compared vine destruction practices for black scurf control in experimental field trials at WSU-Mount Vernon using the cultivar, Red LaSoda, which is very susceptible to Rhizoctonia. Work done in the Netherlands shows that haulm pulling, originally developed for use in seed potato production to limit aphid movement, results in less tuber black scurf than chemical vine killing (Dijst, 1986).

Methods and Results

In the 1991 trial disease pressure resulted from tuberborne AG-3 Rhizoctonia existing naturally on potato seed pieces. In the 1992 trial disease pressure resulted by inoculating plants after emergence with AG-3. Treatments were assigned to two-row plots, 25 feet long, randomized in a RCB design. One-hundred days after planting (the typical maturation date for this variety in the Mount Vernon area), seven vine destruction treatments were employed. These included a control (natural senescence), pulling, cutting, burning, chopping, chemical killing (vines were chopped and sprayed immediately with Diquat herbicide using the 1 pt in 50 gal water/A rate, and again 5 days later), and root undercutting. By harvest (21 days later) green tissue remained on plants in root undercutting, chopping and natural senescence treatments.

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Plants and tubers were sampled at the time of vine kill, weekly for the following 3 wk, and at harvest. Tubers were washed, weighed and rated for scurf using a 0 to 5 scale where 0=no scurf, 1=<5%, 2=5-10%, 3=10-25%, 4=25-50% and 5=>50% of the tuber surface affected with Rhizoctonia sclerotia. Care was taken to do the ratings as consistently and in as nonbiased way as possible. Number of skinned tubers also was recorded.

Average scurf ratings plotted against time revealed that scurf increased the most between 7 and 14 days. The largest increase occurred for burning and cutting followed by pulling and chemical killing, followed by undercutting and chopping, and finally, natural senescence in which there was no increase (Figure 1). In a similar trial we imposed only pulling and chemical killing at 90 days (instead of 100 days) and the same pattern emerged: scurf formation accelerated as a result of destroying vines, whether by pulling or chemical means, and the acceleration was most prominent 7 to 14 days after the time of the treatment (Figure 2).

Harvest was 20 to 22 days following vine kill in each trial. In 1992 there was no significant difference in total yield between pulling, cutting, burning, chopping, and the chemical treatments (Table 1). Natural senescence and root undercutting had higher yield, likely resulting from higher weights in the >10 oz size class. Undercutting resulted in more culls, but the treatment distribution in the 4-10 oz size class, was basically the same as for total yield. In the smaller 1992 vine kill study there was no significant difference in yield between pulling and chemical killing compared to the control which was highest yielding, presumably because of continuing water uptake. The 1991 total yield was significantly lower for pulling compared to most of the other treatments, but not significantly different from chemically killing with Diquat, the same result obtained in 1992 (Table 2).

At harvest, 20 tubers from each plot were randomly sampled for final scurf ratings. The highest scurf ratings were for burning and cutting, followed by pulling and chemical killing and root undercutting, followed by chopping and natural senescence (Table 3). Treatments with lower scurf ratings also had significantly more tubers that were skinned. This result also was obtained in 1991 (Table 4). There was a significant negative linear correlation between scurf rating and skinning incidence both years (r= -.942 and r= -.810).

Conclusions

Vine destruction accelerates scurf formation. With the onset of plant senescence and periderm maturation, Rhizoctonia is triggered to form sclerotia. In this study the treatments in which plants died most slowly (root undercutting, chopping alone, and natural senescence) had more skinned tubers, but with less scurf. Treatments where vines were eliminated or had died fairly quickly (cutting, burning, pulling and chemical killing) had fewer skinned tubers and more scurf. At the onset of this study, we hypothesized that treatments imposing faster vine kill, would result in lower scurf indices. However, now it is obvious that the opposite is true: vine destruction treatments causing plants to die more slowly actually have less scurf.

Since burning and cutting resulted in the highest scurf ratings, these practices should be avoided in situations where scurf is likely to be a problem, and in seed producing areas. Although chopping and undercutting resulted in less scurf formation, these techniques are of no practical value because of poor skin set--one of the primary reasons for killing vines in the first place. Also, the presence of green tissue at the end of the season can promote tuber late blight.

Pulling vines did not significantly alter yield when compared to chemical killing. Halderson (1988) found that pulling of vines of cv Russet Burbank resulted in tuber specific gravities which were equal to those of other vine killing treatments, but since yield from the control was 14% greater, pulling could be done later. Pulling vines in our study did not significantly reduce scurf when compared to chemical killing. This result is different from that reported by Dutch workers, but the chemical vine killing practices they studied were different from the chop/Diquat practice we used (which is the standard practice in western Washington). Undercutting or chopping combined with delayed chemical killing might give a level of scurf control that would be satisfactory without the undesirable effects of skinning or tuber blight, but this topic warrants further research.

References

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Table 1. 1992 yield and pack-out (cwt/a) at harvest.

Trt	U.S. No. 1's Large >10oz	Medium 4-10oz	Small 2-4oz	U.S. No 2's	Culls	All Tubers
Check	66 a	199 a	55	7	5	331 a
Pull	26 c	157 c	56	10	8	257 c
Cut	19 c	167 bc	51	6	6	249 c
Burn	36 bc	180 abc	43	7	4	270 bc
Chop	38 bc	190 ab	41	6	2	277 bc
Chop+DQ	34 bc	168 bc	40	7	3	252 c
Undcut	54 ab	175 abc	44	9	14	296 ab
LSD(.05)	20.63	26.06	NSD	NSD	6.03	36.19

*Each value is the average of five 25 ft plots.

Table 2. 1991 yield and pack-out (cwt/a) at harvest.

Trt	U.S. No. 1's Large >10oz	Medium 4-10oz	Small 2-4oz	U.S. No 2's	Culls	All Tubers
Check	81.7a	173.3a	102.8	33.0	6.8 bc	397.6a
Pull	24.9 b	125.9 c	98.6	28.0	5.9 c	283.3 c
Cut	27.3 b	145.3 bc	111.9	28.3	11 a	323.8 b
Burn	32.4 b	136.1 bc	103.1	29.0	7.4 bc	308.0 bc
Chop	47.7 b	151.6ab	110.9	28.2	6.9 bc	345.2 b
Chop+DQ	31.2 b	153.4ab	98.3	26.3	9.3ab	318.5 bc
Undcut	37.2 b	148.6 b	119.7	25.2	7.9 bc	338.6 b
LSD(.05)	27.05	22.71	NSD	NSD	2.69	39.28

*Each value is the average of six 25 ft plots.

Table 3. 1992 scurf, skinning and stem-end discoloration data.

Treatment	Scurf Rating	% Skinned	% SED
Check	1.680 a	5.0 a	1.8 a
Pull	2.413 bc	0.4 b	2.4 a
Cut	3.160 e	0.4 b	1.0 b
Burn	3.000 de	1.0 b	0.4 b
Chop	1.720 a	4.2 a	0.6 b
Chop+Diquat	2.747 bc	1.4 b	0.4 b
Undercut	2.200 b	5.4 a	0.6 b
LSD (p=0.05)	0.344	3.0	0.7

* Each value is the average of five reps, 20 tubers per rep.

Table 4. 1991 scurf, skinning and stem-end discoloration data.

Treatment	Scurf Rating	No. Skinned	No. SED
Check	1.024 a	4.7 (24%) ab	0.17 (0.8%)
Pull	1.732 c	1.7 (8%) c	1.17 (5.8%)
Cut	1.853 c	2.7 (13%) c	0.83 (4.2%)
Burn	1.840 c	2.2 (11%) c	1.00 (5.0%)
Chop	1.110 ab	5.0 (25%) a	0.83 (4.2%)
Chop+Diquat	1.932 c	1.7 (8%) c	1.00 (5.0%)
Undercut	1.634 bc	3.0 (15%) bc	1.00 (5.0%)
LSD (p=0.05)	0.576	1.898	NSD

* Each value is the average of 6 reps, 20 tubers per rep.

Figure 1. Deposition of Rhizoctonia solani sclerotia on 'Red LaSoda' tubers between the time of vine kill (100 days after planting) and harvest (3 wk later).

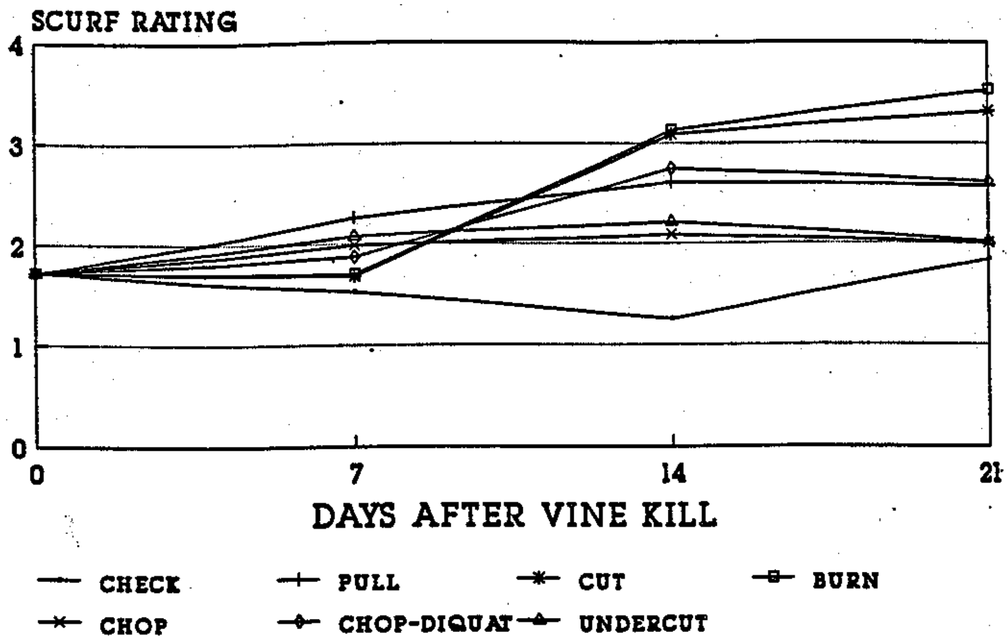

Figure 2. Desposition of Rhizoctonia solani sclerotia on 'Red LaSoda' tubers between the time of vine kill (90 days after planting) and harvest (3 wk later).