# *PROGRESS TOWARDS SCLEROTINIA-RESISTANT VARIETIES*

*Paul Vincelli*
*Extension Plant Pathologist*
*University of Kentucky*

Sclerotinia crown and stem rot (SCSR), caused by the fungus *Sclerotinia trifoliorum*, is one of the most important factors limiting the success of late-summer alfalfa seedings in the region. Infections of *S. trifoliorum* that progress into the crown of a fall-sown alfalfa plant can kill it during winter or spring green up. Stand losses by the following spring may be insignificant (1-3%) or nearly total, with 95-99% of the stand being dead (and often even rotted away and gone by spring green-up).

Several factors account for the substantial risk from this disease in late-summer seedings of alfalfa on Kentucky farms:

(1) The fungus is commonly found in fields and pastures with a history of forage legumes: alfalfa, red clover, white clover, and others (Vincelli & Nesmith, *unpublished data*).

(2) The infectious, airborne spores of *S. trifoliorum* are produced from late October through around Christmas (ref. 14).

(3) Alfalfa plants are most susceptible during the first 8-10 weeks of good growing conditions (ref. 1, 9).

(4) The vast majority of alfalfa varieties on the market are susceptible to SCSR.

The bad news about SCSR is that few control options are available. In a "nutshell", our research to develop reliable cultural controls has been unsuccessful (ref 12; P. Vincelli, *unpubl. data*). Likewise, experimental fungicides can successfully control the disease (ref. 6-9, 11-14) but are neither economical nor legal.

The good news is that alfalfa can be bred for increased resistance to SCSR (ref. 2-5). Unfortunately, to date there is no alfalfa variety with a high degree of resistance to SCSR. Furthermore, UK work conducted a decade ago showed that varieties that exhibited partial resistance to SCSR elsewhere in the U.S. sometimes performed very poorly in Kentucky (12-13), because of the very high disease pressure experienced here (10). After consultations with certain commercial alfalfa breeders, it became clear that selections for increased resistance to SCSR needed to be conducted under Kentucky conditions if adequate levels of resistance were to be achieved.

## THE UK SCLEROTINIA DISEASE NURSERY

The University of Kentucky Departments of Plant Pathology and Agronomy initiated a cooperative project at UK's Spindletop Farm to facilitate breeding progress in alfalfa against SCSR. This program has had two objectives:

1. to provide an opportunity for commercial breeders to select surviving plants from their elite lines following natural epidemics of SCSR;

2. to evaluate the performance of in currently available alfalfa varieties reported to have partial resistance to SCSR.

In order to achieve these objectives, we created a "disease nursery" at the UK Spindletop Research Farm where the following rotation has been practiced:

1. Red clover is drilled into prepared ground in February-March of year 1. Grain infested with *S. trifoliorum* is applied to 6-ft wide strips in October of the same year. The disease is allowed to run its course, though sprinkler irrigation may be provided if conditions are unusually dry.

2. Strips (6-ft wide) of red clover that were not inoculated are rototilled and sown in mid-September of year 2 to alfalfa entries provided by commercial breeders; controls are also sown. The inoculated strips of red clover straddling each strip of alfalfa plots are left undisturbed, to serve as a source of natural ascospore inoculum of *S. trifoliorum*. Each entry is represented by eight plots; four are treated several times with an experimental fungicide (serving as controls), and four are untreated plots. The disease is allowed to run its course.

3. Data on stand survival are collected in May-June of year 3, usually about 14 days after taking the first cutting. Commercial breeders are then invited to select surviving plants from their entries.

There are two aspects of this approach which are important. First, it assures moderate to high disease pressure, minimizing "escapes" (susceptible plants that were not exposed to inoculum), so that breeders have the best chance possible to select plants with genes for resistance. Second, this method allows for plant inoculation in a way that mimics natural field conditions. This increases the likelihood that plants with resistance to ascospore infection will survive and be selected.

## SOME RESULTS FROM THE UK DISEASE NURSERY

We have consistently achieved high disease pressure in these experiments, as evidenced by severe stand loss in the susceptible checks (Tables 1-4). It is important to note that this level of disease pressure has been observed repeatedly on commercial farms in Kentucky (Table 5, for example), so this is not an unrealistic level of disease pressure for an alfalfa seeding to encounter.

In our earliest experiments, we were disappointed to see very poor performance of entries that had been selected to have some partial resistance to SCSR, such as 93-116 and A9109 (Table 1) as well as Interceptor and A9714 (Table 2). While these were disappointing results, these early experiments showed just how far breeders needed to go in order to develop adequate levels of resistance for Kentucky conditions.

**Table 1. Stand density following an outbreak of SCSR at Spindletop Farm (sown 1 Sep 1995)*.**

| | Percent stand on 3 May 1996** | |
|---|---|---|
| Entry | Nontreated plots | Plots treated w/ fungicide |
| MSR ……………………………….. | 21 a | 87 a |
| 93-116 …………………………….. | 8 ab | 86 a |
| A9109 ……………………………... | 7 ab | 81 a |
| 92-31 ……………………………… | 5 ab | 84 a |
| WL-323 …………………………… | 3 ab | 89 a |
| C228 ……………………………… | 2 b | 92 a |
| Armor (susceptible check)………… | 2 b | 94 a |

*Establishment method differed slightly in this trial: alfalfa entries were sown directly into untilled red clover residue killed by SCSR followed by Roundup application.
**Means presented are arithmetic means; statistical groupings are based on arcsine-transformed data. Means for a given date followed by the same letter are not significantly different, Waller–Duncan K-ratio *t*-test (*k*=100, *p*=0.05).

| Table 2. Stand density following an outbreak of SCSR at Spindletop Farm (sown 25 Sep 1998). | | | | |
|---|---|---|---|---|
| | Percent row fill on 8 Jun 1999* | | Percent row fill on 19 Jul 1999* | |
| Entry | Nontreated Plots | Plots treated w/fungicide | Nontreated plots | Plots treated w/fungicide |
| Pioneer 5454 (susceptible check).. | 2 c | 67 ab | 3 f | 78 bc |
| 6030 …………………………….. | 4 c | 58 b | 7 def | 72 c |
| A9714 ……………………………. | 5 c | 78 a | 17 de | 85 ab |
| C416 ……………………………. | 6 c | 79 a | 16 d | 89 a |
| DK141 ………………………….. | 3 c | 73 a | 5 ef | 85 ab |
| Interceptor ………………………. | 3 c | 60 b | 6 ef | 78 bc |
| ZH97 ……………………………. | 5 c | 68 ab | 12 de | 79 bc |

*Means presented are arithmetic means; statistical groupings are based on arcsine-transformed data. Means for a given date followed by the same letter are not significantly different, Waller–Duncan K-ratio *t*-test (*k*=100, *p*=0.05).

As this work has progressed, results have become more encouraging. In recent tests, we have found **all** entries selected for resistance to SCSR provided better stands than the susceptible check, even under high disease pressure (Tables 3 & 4). Furthermore, while Cimarron SR has consistently been shown to have a degree of partial resistance to SCSR under Kentucky conditions, it has been exciting to see that at least one entry in each test had even higher levels of survival than Cimarron SR (Tables 3 & 4).

| Table 3. Stand density following an outbreak of SCSR at Spindletop Farm (sown 18 Sep 2001). | | |
|---|---|---|
| | Percent row fill on 24 May 2002* | |
| Alfalfa entry | Nontreated plots | Plots treated with Fungicide |
| 40t174………………………………… | 64 cd | 99 ab |
| 50t176 ……………………………… | 79 c | 98 ab |
| SR1 ………………………………… | 45 ef | 98 ab |
| SR2 ………………………………… | 46 ef | 99 ab |
| SR3 ………………………………… | 56 de | 100 a |
| SR4 ………………………………… | 40 f | 99 ab |
| WL338 SR ..……………………….. | 66 cd | 100 a |
| Cimarron SR ..………………………. | 51 def | 99 ab |
| MSR2 ……………………………… | 45 ef | 96 b |
| Pioneer 5454 (susceptible check)... | 13 g | 98 ab |

*Means presented are arithmetic means; statistical groupings are based on arcsine-transformed data. Means for a given date followed by the same letter are not significantly different, Waller–Duncan K-ratio *t*-test (*k*=100, *p*=0.05).

**Table 4. Stand density following an outbreak of SCSR at Spindletop Farm (sown**

17 Sep 2002).

| Alfalfa entry | Percent row fill on 15 May 2003* Untreated plots | Plots treated with Fungicide |
|---|---|---|
| 41S145 …………………………….. | 62.5 c | 98.8 ab |
| 50T176 ..………………………….. | 61.3 c | 99.3 ab |
| 51S147 …………………………….. | 38.8 d | 96.3 ab |
| ZG0147a …………………………... | 28.8 de | 93.5 b |
| ZG0150a …...……………………… | 23.0 ef | 96.8 ab |
| ZG0152a ………………………….. | 31.3 de | 96.5 ab |
| V102SR …………………………… | 26.3 de | 94.8 b |
| WL338SR …………………………. | 38.3 d | 99.8 a |
| WPAR02SR ………………………. | 26.3 de | 94.8 b |
| Cimarron SR ……………………… | 41.3 d | 97.8 ab |
| Pioneer 54V54 (susceptible check) | 10.5 f | 96.5 ab |

*Means presented are arithmetic means; statistical groupings are based on arcsine-transformed data. Means in either row followed by the same letter are not significantly different, Waller–Duncan K-ratio *t*-test (*k*=100, *p*=0.05).

## SIGNIFICANCE TO PRODUCERS

Producers will be interested to know that in every test where Cimarron VR or Cimarron SR have been evaluated under high pressure from SCSR, we have seen some degree of stand improvement as compared to a susceptible check. Unfortunately, Cimarron VR and Cimarron SR have not provided complete protection against the disease under high—but realistic—disease pressure. In fact, in a test on a commercial farm, stand survival in Cimarron VR in the spring following sowing was no better than that of the susceptible check, although the stand of Cimarron VR was significantly higher than the susceptible check later in the life of the stand (Table 5). Thus, producers should not expect Cimarron SR or any of the current variety to provide complete control of SCSR. Nevertheless, our results show clear evidence of progress in breeding for partial resistance to SCSR at Great Plains Research, which in fairness was achieved before we started our SCSR disease nurseries and plant digs at UK. If Cimarron VR and Cimarron SR show significant stand improvement under high disease pressure, as they have done in our tests, then I would expect them to perform better--and probably adequately--under lower disease pressure, as some farms experience.

**Table 5. Stand density following an outbreak of SCSR on a commercial farm in Adair County (sown 23 Sep 1996).**

| Cultivar | % ground cover 6 May 1997[1] | % ground cover 12 Apr 2000 | % ground cover 28 Apr 2000 |
|---|---|---|---|
| Cimarron VR …………………………… | 22 | 63 a[2] | 79 a |
| WL 322 SR ……………………………… | 13 | 46 b | 68 b |
| Fortress (susceptible check) ………….. | 7 | 41 b | 62 b |

[1]ANOVA effect for cultivar is insignificant *(P.0.2)*
[2]Means followed by the same letter are not significantly different, Waller-Duncan k-ratio t-test, *k*=100, *P*=0.05

We have also observed significant stand improvement against SCSR with WL 338 SR in two tests. Most encouragingly, FFR Cooperative has a line (50T176, selected through the UK-SCSR nursery) which has performed significantly better than Cimarron SR, with stands of over 60% under high disease pressure in. This is a very encouraging sign. Based on their selections conducted at UK and elsewhere, I expect that in the future, this company will have commercial alfalfa cultivars with moderately high levels of resistance to SCSR.

Sowing alfalfa in late summer poses a risk from SCSR, and variety selection won't completely negate that risk. However, over the past decade we have seen that certain varieties can provide a degree of protection from stand loss, should SCSR be active on your farm. The currently available varieties with partial resistance will not provide complete protection against high pressure from SCSR. However, if planning to seed in late-summer or early autumn, it seems sensible to me to consider sowing those varieties that have been proven to provide some protection against SCSR under the high disease pressure possible in Kentucky.

## Acknowledgements

Thanks to Robert Spitaleri in the UK Dept. of Agronomy, and to Ed Dixon of the UK Dept. of Plant Pathology, for their substantial contributions to making this ongoing work happen.

## References

Brune, P. D., Rhodes, L. H., Panciera, M., Ridel, R. M., and Myers, D. 1988. A histological study of the relationship between plant age and severity of Sclerotinia crown and stem rot of alfalfa. Page 14 in: J. B. Moutray and J. H. Elgin, eds., Report of the Thirty-First North American Alfalfa Improvement Conference, Beltsville. 151 pp.

Halimi, E. S., Rowe, D. E., and Aung, M. 1994. Divergent selection in alfalfa for resistance to Sclerotinia crown and stem rot. Crop Sci. 34:1440-1442.

Pierson, P. E., Rhodes, L. H., and St. Martin, S. K. 1994. Selection for resistance to Sclerotinia crown and stem rot in the field and greenhouse. Page 29 in: R. Michaud and J. H. Elgin, eds., Report of the Thirty-Fifth North American Alfalfa Improvement Conference, Guelph. 211 pp.

Pratt, R. G., and Rowe, D. E. 1994. Responses to selection for resistance to *Sclerotinia trifoliorum* in alfalfa by stem inoculations. Plant Dis. 78:826-829.

Pratt, R. G., and Rowe, D. E. 1996. Registration of Mississippi *Sclerotinia*-Resistant (MSR) germplasm. Crop Sci. 36:821-822.

Rhodes, L. H. 1992. Evaluation of alfalfa varieties and experimental lines for resistance to Sclerotinia crown and stem rot, preliminary report, 1991-92. Xeroxed report, 5 pp.

Rhodes, L. H. 1993. Evaluation of alfalfa varieties and experimental lines for resistance to Sclerotinia crown and stem rot, 1992-93. Xeroxed report, 6 pp.

Rhodes, L. H., and Sulc, R. M. 1995. Evaluation of alfalfa varieties and experimental lines for resistance to Sclerotinina crown and stem rot, 1994-95. Xeroxed report, 4 pp.

Sulc, R. M., and Rhodes, L. H. 1997. Planting date, fungicide, and cultivar effects on Sclerotinia crown and stem rot severity in alfalfa. Plant Dis. 81:13-17.

Vincelli, P. 1998. What's known and what's new with *Sclerotinia* resistance? Pages 15-21 in: Proc. Twenty-Eighth National Alfalfa Symposium, G. Lacefield, ed. 173 pp.

Vincelli, P. C., Collins, M., and Doney, J. 1992. Control of Sclerotinia crown and stem rot, 1990-91. Fung. Nemat. Tests 47:211.

Vincelli, P., Doney, J. C., Lauriault, L. M., and Wang, L. 1997. Evaluation of A9109, seeding date, and dormant harvest for managing Sclerotinia crown and stem rot of alfalfa, 1995-96. Biol. & Cult. Tests. 12:19.

Vincelli, P., Doney, J. C., Lauriault, L.M., and Wang, L. 1997. Field response of alfalfa lines selected for partial resistance to *Sclerotinia trifoliorum*, 1995-96. Biol. & Cult. Tests. 12:20.

Vincelli, P., Doney, J. C., and Wang, L. 1996. Dynamics of apothecial populations of Sclerotinia trifoliorum. Page 58 in: W.T. W. Woodward and J. H. Elgin, eds., Report of the Thirty-Fifth North American Alfalfa Improvement Conference, Oklahoma City. 111 pp.