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EFFECT OF NUT SCAB ON PECAN YIELD AND QUALITY COMPONENTS

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ABSTRACT

A test was conducted over a three year period on three pecan cultivars to determine the effect of scab disease on some yield and quality components of pecan production. Disease progress curves were generated and compared for effect on yield and quality values. The effect of scab on yield components ranged from complete crop destruction to reductions in yield weights of five to sixty percent. The major damage caused by scab in this test was recorded from disease increases in Jul. Increases throughout Aug also significantly reduced yield. Extreme scab severity by the end of Jul decreased the oil content of the kernels.

INTRODUCTION

Since its recognition in the late 1800's (Ellis and Everhart 1888), pecan scab has generally been considered to be the most important disease of pecan *(Carya illinoinensis)* in terms of potential crop loss, and economics of control. This disease, incited by *Cladosporium caryigenum* is one of the limiting factors in commercial production of pecans in the southeastern U.S. (Littrell and Bertrand 1981). The statement that scab disease is one of the most economically important factors of pecan production has been made in one form or another in dozens of publications since commercial production began in the early part of this century. Commercial production of pecan cultivars in the southeastern U.S. is dependent on control of scab with multiple fungicide applications each year (Littrell and Bertrand 1981). With the recognition that scab is a serious disease, it could be assumed that the specific effects of the disease on crop production have been extensively studied. However, this is not the situation, in fact, very few research efforts have addressed the effect of the disease on nut production. Previous reports have indicated that leaf damage can vary from defoliation to destruction of localized areas (Demaree 1924, Demaree and Cole 1929). Because of the complexity of directly connecting leaf infections with crop damage in a perennial tree crop such as pecan, there have been no specific data collected to indicate the effect of leaf infection by the scab pathogen on crop development. However, physiological studies, as well as defoliation experiments show that leaf loss does effect production potential of nut trees (Marquard 1987, Sitton 1931, Sparks and Brack 1972, Sparks and Davis 1974, Worley 1971). Most of the reports on scab damage have described total crop loss as a result of extreme nut infection. Many of these reports were based on data obtained during fungicide trials (Demaree 1924, Barnes 1959, Barnes 1966, Barnes 1974, Barnes 1977, Cole 1948, Cole 1964). Generally, scab disease control recommendations had been based on the potential for complete crop loss, and reports that tissue can be infected from bud break through nut maturity.

Two research efforts have specifically addressed the effects of nut infection on yield and quality (Gottwald and Bertrand 1983, Hunter 1983). One report indicated that increases in scab from mid- Jun to nut maturity may not have a significant effect on yield and quality of the crop, and that scab did not cause any increases in total end of year nut drop (Gottwald and Bertrand 1983). The report by Hunter indicated that a direct correlation existed between increase in scab in Jul and late season nut drop (Hunter 1983). As the authors indicated these were preliminary studies into an area that had not been previously investigated.

Because of the importance of this area of research to pecan production practices, a study was initiated in 1991 to collect additional data on the effects of scab on yield and quality components.

PROCEDURES

The test was conducted over a three year period, 1991-1992 at the LSU Agricultural Center Pecan Research-Extension Station. During 1991 and 1993, three cultivars (cv. 'Desirable', 'Schley', and 'Maramec') were included in the study; in 1992 only the 'Desirable' trees had enough nuts to be used. Treatments consisted of disease progress curves which were generated by plotting disease severity with time. Different levels of disease severity were obtained by the use of differential fungicide application schedules to allow for different time periods during the course of the growing season when the nuts were not protected from infection. Each tree was a replicate with individual nut clusters tagged on each replicate. Fungicide applications were applied only to the tagged clusters on each tree throughout the growing season. The clusters were monitored for nut drop and disease severity through the growing season. Disease severity was based on percent of the shuck surface of each cluster that was covered with scab lesions. The severity scale used was: 0%, 1-10%, 11-30%, 31-50%, 51-70%, 71-90%, and 91-100% of the shuck surface covered with lesions. A mean disease severity for each replicate was obtained from the severities of the tagged clusters on each tree. The severity rating for each replicate was used to obtain a mean severity level for each evaluation date for the treatments.

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The nuts in the tagged clusters were collected at shuck split, and allowed to dry at room temperature. After the weight of the nuts had stabilized, the length, diameter, nut weight, and kernel weight of each nut was measured. The calculated means of each replicate were used to compare the effect of the disease progress curves on nut development. The effect of scab on the color of the kernels was determined subjectively by the independent evaluation of four or more individuals who were not familiar with the treatments of the test. The kernels were rated as either golden, light brown, medium brown, or dark brown. The kernels were then sent to the Louisiana State University Agricultural Center Agricultural Chemistry Lab at Baton Rouge to determine the protein and oil percentages.

RESULTS AND DISCUSSION

Representative disease progress curves generated for each cultivar in 1991, along with the corresponding yield component data calculated from the nuts of the tagged clusters are shown in Figures 1-3. Because of frequent rain periods and high rainfall amounts from Apr through Jul, scab development on unprotected nut clusters was intense from late Jun through Jul. This essentially represented a worse case scenario. On the unprotected nuts of each cultivar (Figures 1-3, curve "G"), 85-100% of the nuts in the tagged clusters were aborted by the end of Sep. The disease curves associated with these nut drop totals each had a severity level of 31-50% in the first week of Jul, and were at or near 100% infection by 1 Aug. Interestingly, other disease curves in 1991 were generally not associated with a significant increase in nut drop. For example, on 'Desirable', another curve (not shown) that approached 100% infection in early Aug, and was at a level of 1-10% in early July did not induce excessive nut drop. A 'Maramec' disease progress curve that was at 11-30% in early Jul and reached 100% by mid-Aug (not shown) also was not associated with extra nut drop; however, in other years this type of curve did result in almost complete nut loss.

The 1992 and 1993 growing seasons were closer to "typical" years with regard to scab disease development. The untreated nut clusters of 'Desirable' had infection levels of 11-30% during the first week of Jul, and reached 91-100% in mid- Aug (Figures 4 and 5, curve "F"). Even though this was a considerably slower rate of disease progress than was recorded in 1991, the crop on these trees again suffered high levels of nut drop. The nuts on these clusters had a total drop of 82% and 90% in 1992 and 1993, respectively (Figures 4 and 5). The untreated clusters of 'Maramec' in 1993 (Figure 7, curve "D") reached the 11-30% infection average near mid-Jul, and 100% after Sep. These nuts exhibited an end of year drop of 43% compared to 25% from clusters associated with final infection levels of less than 11-30% (Figure 7). The untreated 'Schley' nuts in 1993 did not reach 11-30% until near the end of Jul, and this level of disease progress apparently did not induce any additional nut drop. Most of the nut drop associated with scab occurred after the "normal" post pollination drop in Jun, and was most evident in Jul and Aug, although scab induced nut drop continued until harvest (Figure 8).

These observations support Hunter's conclusion that scab disease can cause late season nut abortion, but no linear correlation was evident between the amount of scab in early Aug and the degree of nut drop induced (Hunter 1983), Generally, an infection level of 11-30% in early Jul, followed by rapid progress in infection so that a level of near 100% infection was obtained by mid-Aug, resulted in nearly 100% end of season nut drop. Other disease progress curves apparently caused a little or no additional nut drop. In 1991, on each of the three cultivars, a progress curve was generated that was 11-30% or higher in the first week of Jul, but had slowed progress through the rest of the season. No additional nut drop was associated with any of these curves (Figures 1 "C", 2 "D", and 3 "D"). This suggests that for scab to induce nut drop above the "normal" drop the infection level has to not only be high in early Jul but must continue to progress rapidly to near 100% infection of the shucks.

In 1991, the tagged clusters with the most rapid disease progress curve lost practically all of their nuts (Figures 1-3). A few untagged untreated nuts with severe levels of scab that did remain on the trees until maturity were collected to measure the effect of severe scab on nut size and weight. These nuts were of such poor quality that they would not have been marketable; all three cultivars had a 60% or greater weight loss compared to nuts from clusters with the lowest disease curves. The nuts per pound were 146, 168, and 175 for 'Desirable', 'Schley', and 'Maramec', respectively (Figures 1-3, curve G). Similar results were recorded in 1992 and 1993 with the 'Desirable' nuts collected from the clusters with the most intense disease curves (Figures 4 and 5, curve "F"). There is no doubt that severe infection by early Jul combined with continued disease progress near 100% infection by mid-Aug will destroy a pecan crop through nut abortion and greatly reduced size and weight of those nuts that do reach maturity.

When scab was at a level of 1-10% or lower in the first week of Jul, and increased steadily afterwards through the remainder of the season (Figures 1 "E" & "F", 2 "F", 6 "E", and 7 "D"), loss of nut weight was usually quite large (33 to 47% in the examples), and was influenced by the rate of disease increase. These nuts were also significantly smaller in size and kernel weight. The percent weight loss for these kernels was greater than the percent weight loss of the nuts from these samples and ranged from 38 to 57%. This seems to suggest that scab had a greater effect on kernel development than on shell development. The percent kernel reduction for the examples shown varied form 2 to 12%.

Three curves are shown in which scab is near 1- 10% severity in mid-Jul and increases afterward. The size and nut and kernel weights of the nuts collected from the clusters with two of these progress curves (Figure 4 "D" and "E") were significantly less than nuts collected from clusters with a final disease level of 1-10% in Oct. These two nearly parallel curves illustrate the importance of the rate of disease increase on yield components. The nuts from the clusters that had attained an infection of 60-80% in mid-Aug had a 40% reduction in yield, while those nuts that reached 60 - 80% infection in Oct had a 10 % nut yield loss. The nuts from this later group actually did not exceed 1-10% infection until the end of Jul. The percent kernel weight loss was 45 and 12 for the nuts with corresponding 40% and 10% nut weight loss, while the reduction in percent kernel was 4.1 and 0.8, respectively. Percent kernel is not as useful for evaluating the effect of scab on nut development as is weight of the nuts and kernels, because the primary effect of scab is size and weight reduction while the effect on percent filling is not as pronounced. The nuts collected from the tagged clusters with one of the disease curves in this group (Figure 2 "E") were not reduced in size or weight. Oddly, nuts that were associated with another curve in 1991 on 'Schley' that also was 1- 10% severity in mid-Jul but that increased at a slower rate, were reduced in weight.

Four curves are shown that demonstrate the effect of scab on yield components when the severity level exceeded 1-10% after late Jul or early Aug. The results from the 1992 'Desirable' group curve (10% nut wt and 12% kernel wt. loss) have already been discussed. The other three curves are from 'Maramec' 1991, 1993 and 'Desirable' 1993 (Figures 3 "F", 5 "E", and 7 "C"). These progress curves are similar and the nuts collected from the clusters yielded very similar results. The nut weight loss was 19-24%, and kernel weight reduction was 28-31%, with 4-7% lower kernel shellout compared to nuts from the respective lowest disease curve of each year which were near 1-10% severity at the final evaluation period. Even though there was a large difference in the weight of the 'Maramec' nuts and kernels associated with the development of scab after Jul, there was little or no effect on nut size. The 'Desirable' nuts were significantly reduced in size. It should be noted that the 'Desirable' nuts did not much exceed the 1 - 10% class until after mid- Aug. The greater reduction in kernel weight relative to nut weight loss again suggests that scab has more effect on kernel development than shell growth.

Seven curves are illustrated for increases in scab above 1-10% infection after the middle of Aug. The two curves in this group (Figures 3 "E" and 6 "D") with the fastest rate of progression were on trees with the greatest yield reduction values in this group. The yield values for the nuts from the 'Schley' - 1993 curve were reduced as follows: nut weight 16%, kernel weight 23%, and percent kernel 5.7% (Figure 6 "D"). Nuts from the 'Maramec' - 1991 "E" curve similarly had weights reduced by 14 and 18% for the nuts and kernels, respectively (Figure 3 "E"). The diameters of the respective 'Schley' and 'Maramec' nuts were only slightly reduced, and the nut length was not significantly affected.

Two other curves in this group had progressed from a level of 1-10% in mid- Aug to 31-50% severity in mid-Sep (Figures 1 "B" and 2 "C"). The 'Schley' nuts were reduced in weight by 8% and the kernels by 13%. The 'Desirable' nuts from 1991 curve "B" had a significant kernel weight reduction of 9%. The nut weight was not significantly reduced when compared to nuts collected from the trees with the lowest disease curve; although, the lowest disease curve of 'Desirable' - 1991 had a final severity level of 11-30%. The size of the 'Schley' and 'Desirable' nuts from these two curves was not affected.

The other three curves in the group that increased above 1-10% severity after mid-Aug had only minor disease progression and the nuts associated with these curves exhibited only small or no effects in yield values relative to the nuts from the corresponding lowest disease curves (Figures 2 "B", 4 "C", and 5 "C").

Two curves from 'Maramec' 1991 increased from 1-10% at the end of Aug to 11-30% in mid-Sep (Figure 3 "B" and "C"). Nuts collected from the "C" curve terminals had lower nut and kernel weights, the nuts with the "B" curve severity were not significantly different from the nuts with a final severity of 1-10%, curve "A". The "C" curve had a somewhat higher severity level than the "A" curve from Jul to mid-Aug, and "B" had a lower severity than "A" through mid-Aug. This suggests that even low levels of infection during this period can sometimes reduce yield values.

Two other curves that progressed slowly from 1- 10% at the end of Aug to final severity of near 11- 30% in Oct were the "B" and "D" curves of 'Desirable' - 1993 (Figure 5 "B" and "D"). The yield values were only slightly different than the nuts from the terminals with the lowest disease progress curve, and, in fact, the nuts from the "B" curve were a little larger and heavier than the "A" curve nuts. Unfortunately, no curves were generated that had low levels of scab at the end of Aug with a subsequent rapid disease progression. This was because of a lack of rainfall periods to induce infections, and perhaps because of the decreasing susceptibility of the shucks to infection in Sep. Thus, the potential effects of large increases in scab during Sep were not determined in this test. Results of relatively small differences in scab progression in Sep were not definitive.

It may seem odd for a substantial kernel weight reduction not to be accompanied by a similar amount of reduction in percent kernel, especially in instances where there is no significant change in nut size. One possible explanation of this is that there is a reduction in shell weight even without a detectable change in nut size. To test this possibility, the five occurrences where a kernel weight reduction was not accompanied by a nut size reduction in this study were examined to see if there was a change in shell weights. The five occurrences were 'Schley'- 1991, "C", 'Maramec' - 1991 "C" and "F", 'Desirable' - 1992' "C", and 'Maramec' - 1993 "C". In each instance the change in percent kernel could be accounted for by the shell weight and kernel weight changes. Even though these shell weight reductions were small (0.2 to 0.3 g) they represented a 4 to 7.5% weight reduction of the shell. This weight reduction explained the difference between percent kernel weight loss and percent kernel. For example 'Maramec' - 1993 curve "C" (Figure 7 "C") had a kernel weight reduction of near 28% compared to the kernels from the respective "A" curve, but only a 6.1% decrease in percent kernel. However, the shells of the nuts from the "C" curve also weight 7.3% less than the shells from the "A" group. The shell weight change somewhat negates the effect of reduced kernel weight on percent filling.

Because of the consistency of a reduction in yield components associated with increases in scab severity in Jul and Aug, it would appear to be a good production practice to protect pecans from infection through Aug to prevent economic yield losses. Often growers have the impression that scab has not damaged their crop because the nuts are well filled with normal appearing kernels. A 10% or more reduction in weight may not be easily detected by observation, but it is certainly detectable in terms of profitability. In most production and market situations an increase in yield of 5% would justify the cost of a single fungicide application.

A frequently asked question from growers is if it is economically wise to continue a fungicide application program after a significant level of infection has occurred early in the season. In 1991, an attempt was made to collect data relative to this situation by generating disease curves with relatively high infection levels in Jul followed by a slowed rate of disease progression through fungicide applications. These curves are shown in Figures 1 "C", 2 "D", and 3 "D". As would be expected, the effects on yield components was dramatic. The 'Desirable' curve (Figure 1 "C") was near a level of 31-50% severity through mid- Aug then progressed to a level of 51-70 % in Sep. The yield values from the nuts with this progress curve were similar to nuts that had a relatively low amount of infection in early Jul and then increased rapidly to over 80% severity at the end of Aug (Figure 1 "F"), yield weights were reduced by almost 40%. Very similar values were recorded for the nuts from the 'Schley' curve that progressed form 11-30% on 3 Jul to 31-50% in early Aug where the severity remained through the end of Sep. Yield weights were reduced by over 40%, and were comparable to nuts collected from the "F" curve which increased in severity from Jul through Sep (Figure 2 "D" and "F"). The 'Maramec' curve in this group had a severity rating of 11-30% in early Jul, but did not reach the 31- 50% level until mid-Sep. The nuts were reduced in weight by over 25% (Figure 3 "D"). These results demonstrate that infection levels of 11-30% in the first week of Jul will cause a major reduction in yield even when scab progression is suppressed through the rest of the growing season. Nonetheless, it is certainly better to harvest 60% of a crop at some market value than to lose the entire crop, which would generally happen if disease was allowed to progress uninhibited throughout the year on susceptible cultivars. The similarity in yield losses between nuts from curves that were relatively high in severity in early Jul with slowed progression through the rest of the year, and nuts from curves that were relatively low in early Jul followed by disease progression through the rest of the season suggests that it is equally important to protect nuts from scab disease throughout most of the season.

The effects of scab disease on quality components were measured as changes in kernel color, and percent oil and protein in the kernels. The effects on quality components were not as dramatic as effects on yield components. Only three of the disease progress curves shown from the test in 1991 and 1992 were associated with kernels that had significantly lower percent oil compared to the curves with the lowest disease severity ("A" curves) (Table 1). These three curves were the ones with the fastest rate of disease development on 'Desirable' in 1991 and 1992, and 'Maramec' in 1991. None of the disease progress curves on 'Schley' in 1991 were associated with an effect on percent oil. These results are similar to previously reported effects of scab on kernel oil content (Gottwald and Bertrand 1983). The flavor of pecans is largely determined by their oil content, there is a possibility that a decrease in percent oil would effect the flavor of the kernels. As the percent oil of the kernels decreases the percent protein tends to increase. It is speculated that the percent of protein increases simply because of the decrease in amount of oil in the kernels.

No consistent effects of scab on kernel color were noted. The kernels from the nuts with the most severe scab were easily recognized because of small size, and sometimes deformed appearance, but even these were apparently not consistently changed in color.

It should be pointed out that determination of the severity of scab was subjective, and was no doubt influenced by the evaluator. It would be useful in evaluating the effects of scab on nut production if a more accurate means of severity determination was available. During severity evaluation no distinction was made between new infections and lesion enlargement from previous infections. This could be particularly important in evaluating late season disease increase.

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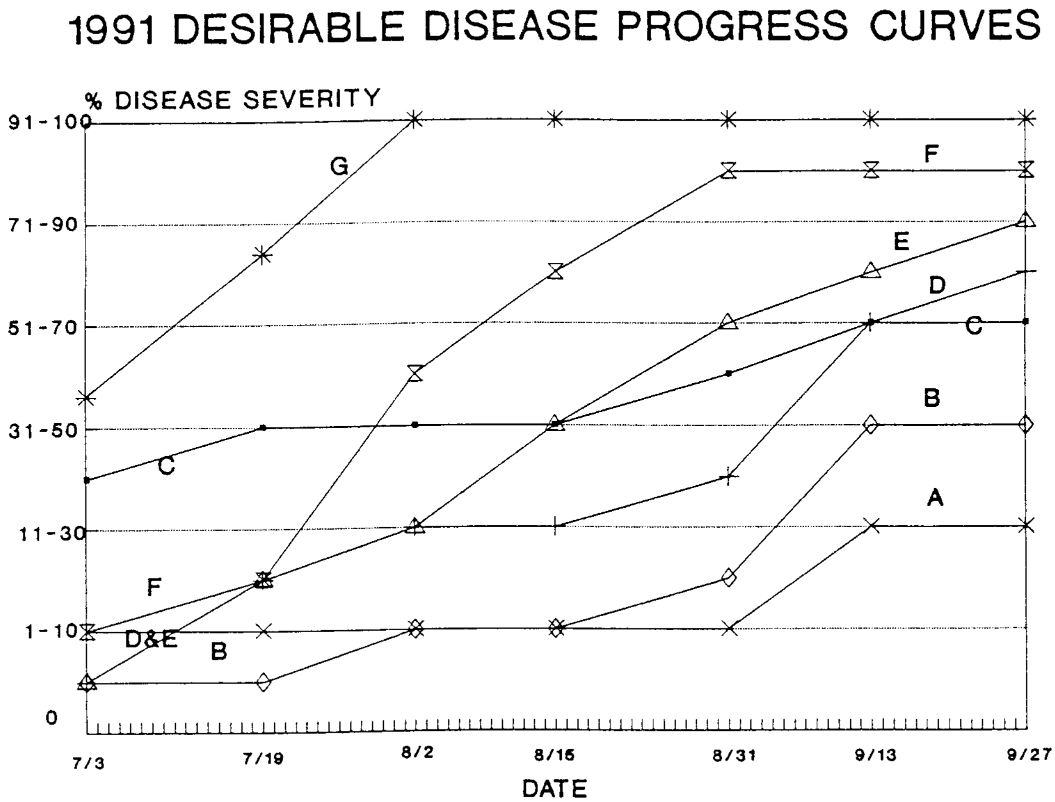
Table 1. Percent of protein and oil in kernels of nuts with various scab disease progress curves.

			Disease Progress Curves[1]													
			A[2]		B		C		D		E		F		G	
			%	%	%	%	%	%	%	%	%	%	%	%	%	%
Fig	Cultivar	Year	Pro	Oil	Pro	Oil	Pro	Oil	Pro	Oil	Pro	Oil	Pro	Oil	Pro	Oil
1	Desirable	91	11.6	58.8	12.5	61.8	12.1	59.7	12.0	57.9	13.7	61.2	13.6	56.8	14.2	44.1*
2	Schley	91	7.9	70.8	7.7	69.7	8.1	71.9	10.3*	67.6	8.7	69.8	9.1	70.1	11.3*	69.5
3	Maramec	91	9.1	68.3	8.3	68.2	8.7	69.3	8.3	69.0	8.5	67.4	9.3	60.4	10.9*	57.8*
4	Desirable	92	11.1	62.0	11.5	62.0	13.0*	59.9	12.8*	62.0	13.0*	62.7	14.6*	46.0*	-	-

[1] Disease Progress Curve designations from Figures 1-4.
[2] Asterisk indicates significant difference from corresponding value of curve "A" within rows, (LSD, P=0.05).

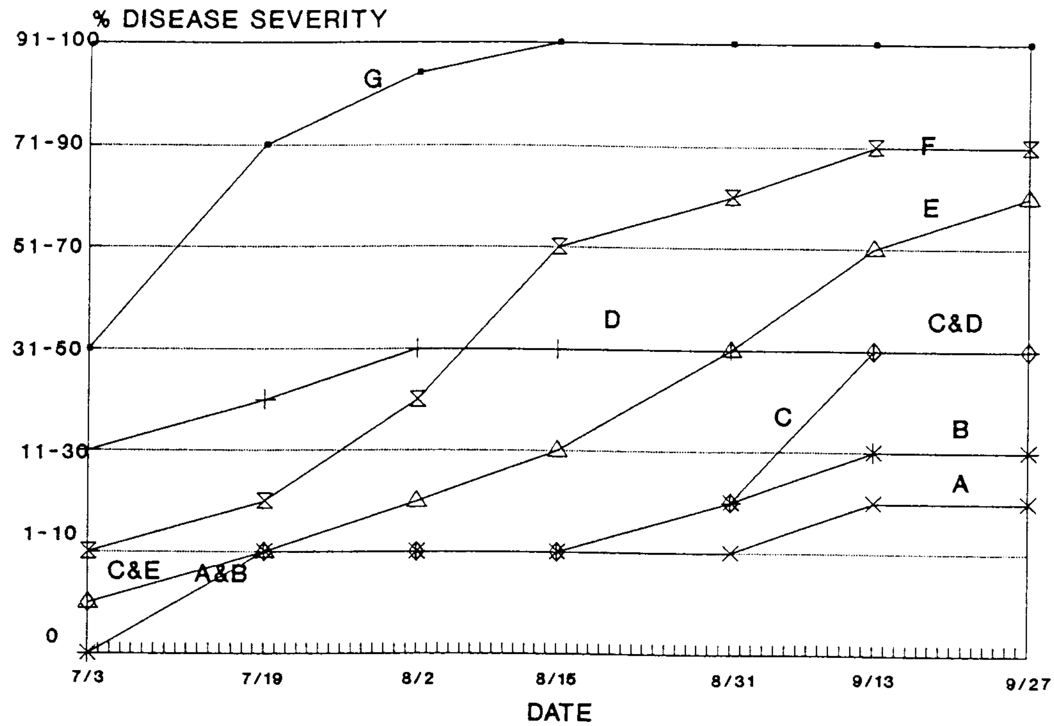


YIELD COMPONENT VALUES

Curve loss	% Drop	Nut Lgth (mm)	Nut Dia (mm)	Nuts/ lb	Ker/ lb	% Nut wt loss	% Ker wt
A	33	42.4	24.7	48.3	85.6	-	-
B	41	41.8	24.9	49.3	94.5*	-	9.4
C	41	33.5*	24.0	79.6*	141.8*	39.3	39.6
D	30	38.6*	24.5	57.4*	108.0*	15.9	20.7
E	39	36.7*	23.3*	72.0*	137.5*	32.9	37.7
F	38	38.0*	22.0*	79.6*	151.2*	39.3	43.4
G	100	28.9*	19.3*	146.3*	302.4*	67.0	71.7

Figure 1. Representative scab disease progress curves and corresponding yield component values from cv. 'Desirable' in 1991. Asterisk denotes significant difference from "A" curve value (LSD, P=0.05).

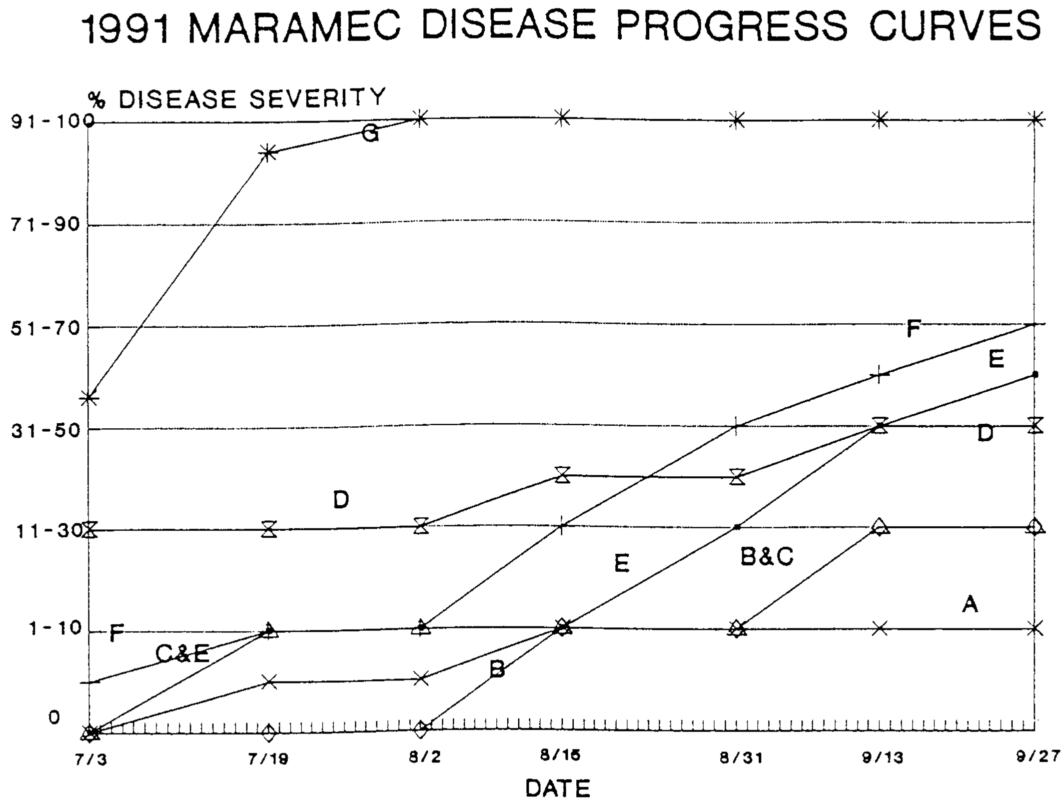
1991 SCHLEY DISEASE PROGRESS CURVES



YIELD COMPONENT VALUES

Curve loss	% Drop	Nut Lgth (mm)	Nut Dia (mm)	Nuts/ lb	Ker/ lb	% Nut wt loss	% Ker wt
A	41	44.1	21.1	61.3	98.6	-	-
B	41	44.3	21.4	59.7	96.5	-	-
C	68	44.2	21.2	66.7*	113.4*	8.1	13.1
D	54	37.5*	18.9*	108.0*	181.4*	43.2	45.6
E	58	44.1	21.1	63.0	105.5	-	-
F	73	40.6*	19.5*	103.1*	174.5*	40.5	43.5
G	100	33.6*	15.2*	168.0*	283.5*	63.5	65.2

Figure 2. Representative scab disease progress curves and corresponding yield component values from cv. 'Schley' in 1991. Asterisk denotes significant difference from "A" curve value (LSD, P=0.05).

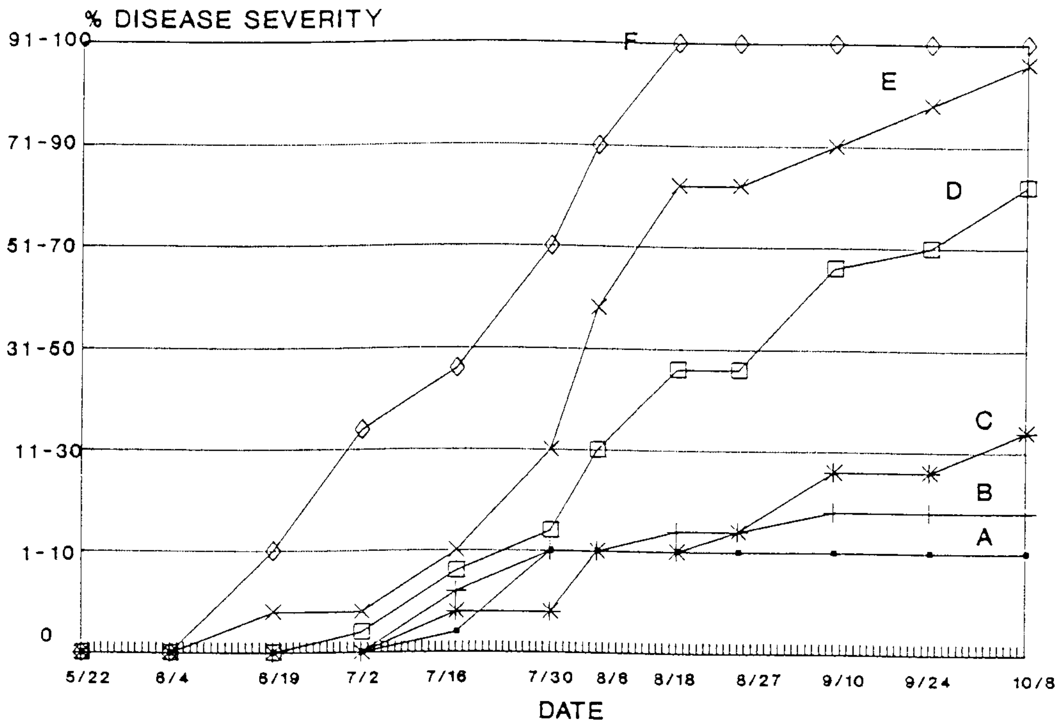


YIELD COMPONENT VALUES

Curve loss	% Drop	Nut Lgth (mm)	Nut Dia (mm)	Nuts/ lb	Ker/ lb	% Nut wt loss	% Ker wt
A	61	49.5	21.6	46.7	81.0	-	-
B	52	49.9	21.9	47.7	84.0	-	-
C	42	48.9	21.6	51.5*	92.6*	9.3	12.5
D	48	43.3*	20.8*	63.9*	110.6*	26.9	26.8
E	38	48.7	21.2*	54.0*	98.6*	13.5	17.8
F	19	50.0	21.3	58.9*	116.3*	20.7	30.4
G	85	37.1*	17.3*	174.5*	412.4*	73.2	80.4

Figure 3. Representative scab disease progress curves and corresponding yield component values from cv. 'Maramec' in 1991. Asterisk denotes significant difference from "A" curve value (LSD, P=0.05).

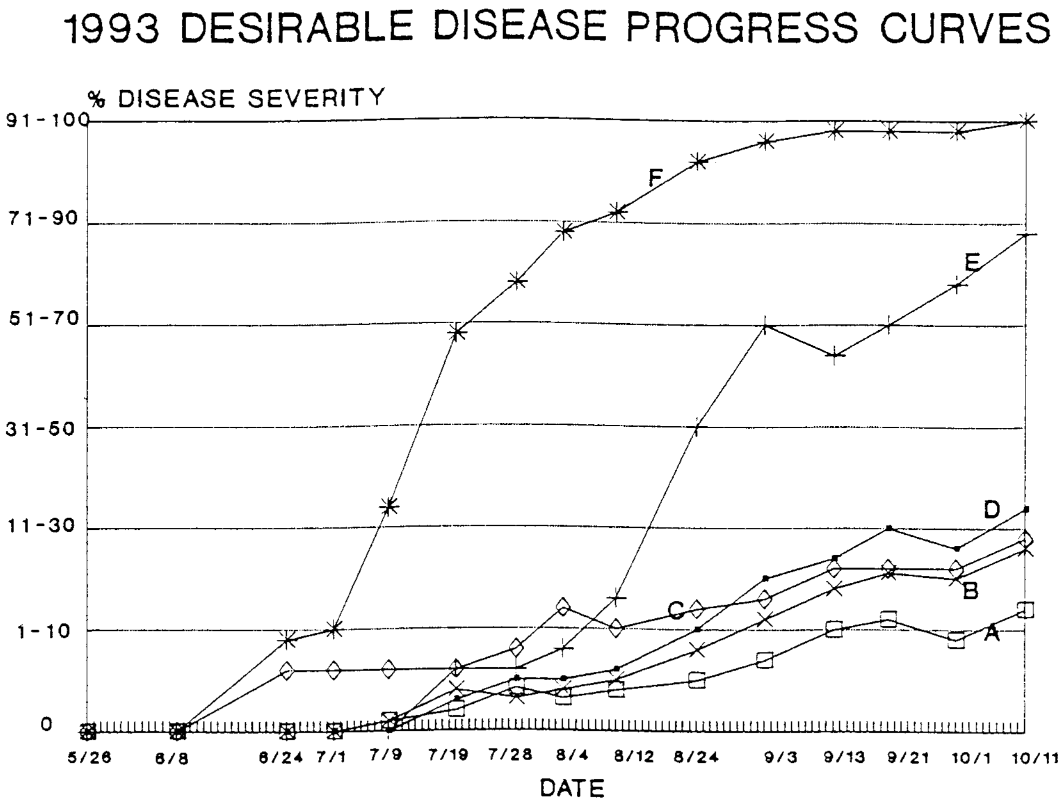
1992 DESIRABLE DISEASE PROGRESS CURVES



YIELD COMPONENT VALUES

Curve loss	% Drop	Nut Lgth (mm)	Nut Dia (mm)	Nuts/ lb	Ker/ lb	% Nut wt loss	% Ker wt
A	60	42.6	24.1	49.3	92.6	-	-
B	59	42.8	24.5*	50.4	96.5*	-	4.0
C	59	42.4	24.2	51.5*	96.5*	4.3	4.0
D	58	40.8*	24.1	55.3*	105.5*	10.8	12.2
E	68	37.4*	21.7*	82.5*	168.0*	40.2	44.9
F	82	31.0*	18.7*	162.0*	412.4*	69.6	77.5

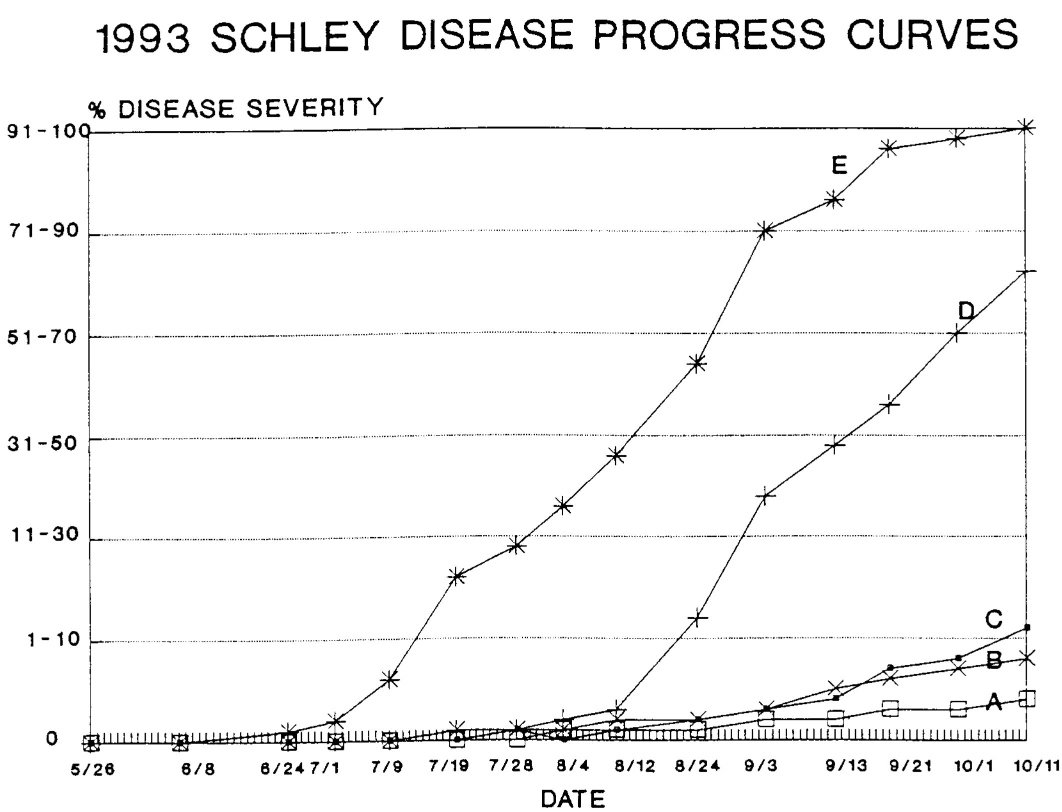
Figure 4. Representative scab disease progress curves and corresponding yield component values from cv. 'Desirable' in 1992. Asterisk denotes significant difference from "A" curve value (LSD, P=0.05).



YIELD COMPONENT VALUES

Curve loss	% Drop	Nut Lgth (mm)	Nut Dia (mm)	Nuts/ lb	Ker/ lb	% Nut wt loss	% Ker wt
A	39	42.9	23.7	49.8	98.6	-	-
B	43	43.6*	24.1*	48.3*	92.6*	-	-
C	52	42.0*	23.6	52.1*	103.1*	4.4	4.4
D	48	43.5*	24.1*	50.4	100.8*	-	-
E	43	41.2*	22.8*	65.7*	141.8*	24.2	30.5
F	90	32.9*	19.8*	126.0*	324.0*	60.5	69.6

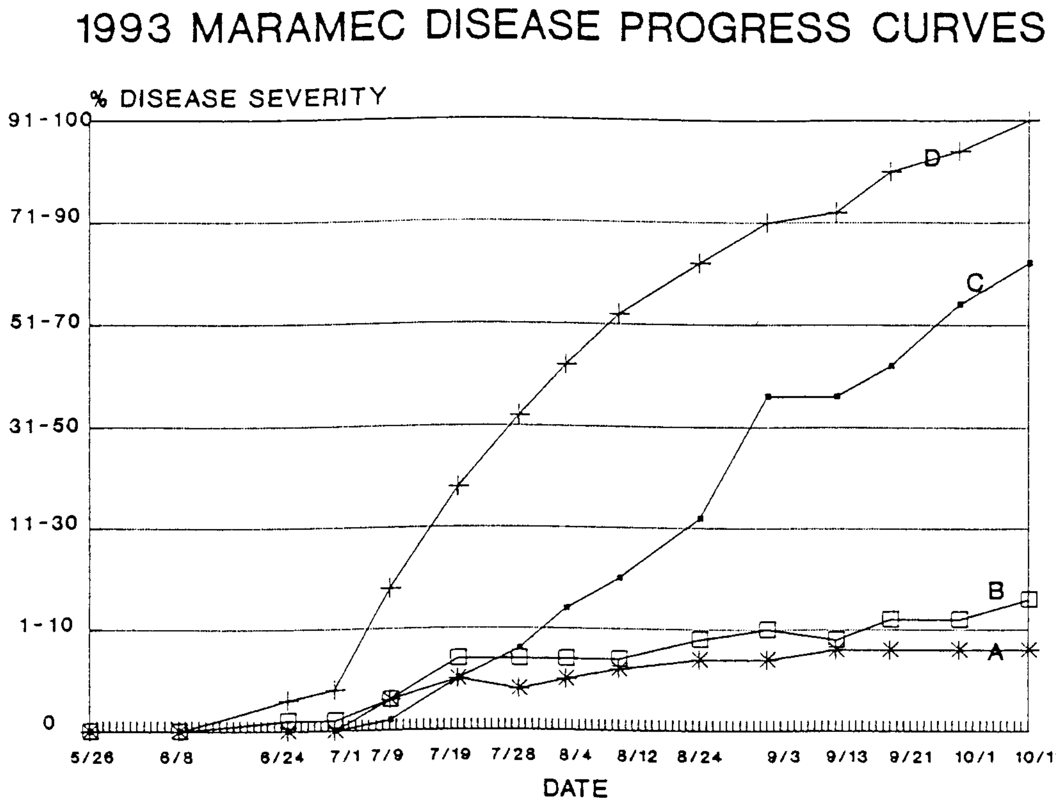
Figure 5. Representative scab disease progress curves and corresponding yield component values from cv. 'Desirable' in 1993. Asterisk denotes significant difference from "A" curve value (LSD, P=0.05).



YIELD COMPONENT VALUES

Curve loss	% Drop	Nut Lgth (mm)	Nut Dia (mm)	Nuts/ lb	Ker/ lb	% Nut wt loss	% Ker wt
A	49	43.6	21.1	58.9	98.6	-	-
B	41	43.9	20.9	58.2	98.6	-	-
C	44.6*	21.1	57.4	98.6	98.6	-	-
D	47	43.6	20.8*	72.0*	133.4*	16.0	22.7
E	55	40.7*	19.5*	113.4*	238.7*	46.6	56.8

Figure 6. Representative scab disease progress curves and corresponding yield component values from cv. 'Schley' in 1993. Asterick denotes significant difference from "A" curve value (LSD, P=0.05)



YIELD COMPONENT VALUES

Curve loss	% Drop	Nut Lgth (mm)	Nut Dia (mm)	Nuts/ lb	Ker/ lb	% Nut wt loss	% Ker wt
A	25	49.0	21.6	45.8	78.2	-	-
B	24	48.3*	21.6	47.7*	82.5*	4.0	5.2
C	36	48.5	21.6	56.7*	108.0*	19.2	27.6
D	43	42.9*	19.4*	82.5*	162.0*	44.5	51.7

Figure 7. Representative scab disease progress curves and corresponding yield component values from cv. 'Maramec' in 1993. Asterisk denotes significant difference from "A" curve value (LSD, P=0.05).

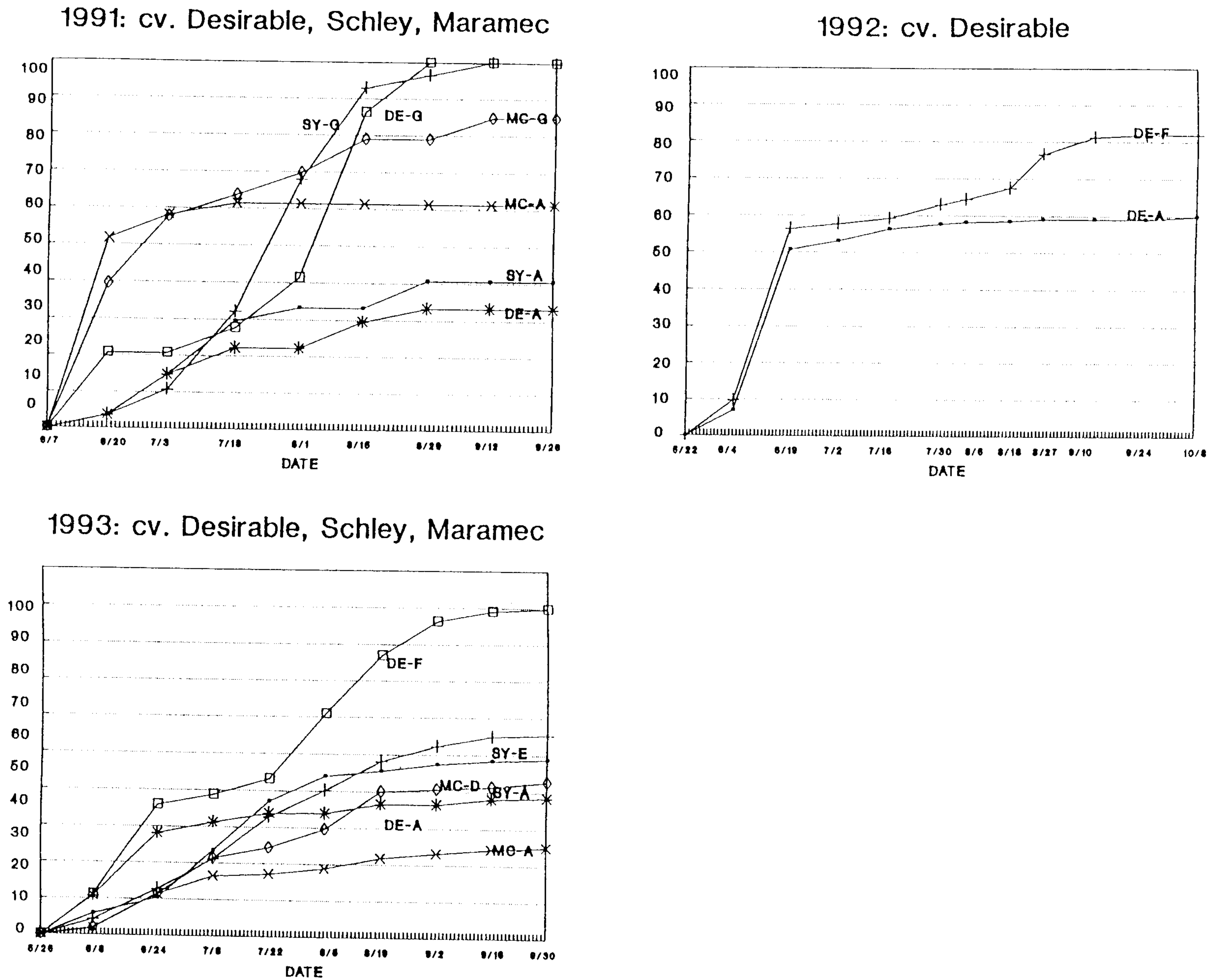


Figure 8. Cumulative percent nut drop patterns associated with the disease progress curves with the least and most disease severity of Figures 1-7. DE=Desirable, SY=Schley, Mc=Maramec.