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| **Reporting Period** | Final Report |
| **Proposal** | [2215 Compile Estimates of Soybean Yield Suppression by Diseases in the U.S. during 2011](http://moss.unitedsoybean.org/Lists/Proposals/DispForm.aspx?ID=2695&RootFolder=*) |
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**United Soybean Board Domestic Programs**

**Final Report**

**Project #:** 2215

**Project Title:** Compile Estimates of Soybean Yield Suppression by Diseases in the U.S. during 2011

**Principal Investigator:** Carl A. Bradley, University of Illinois

**Principal Period:** Final Report

**Project Objective:**

The objective of project #2215 was to compile estimates of soybean yields suppressed by individual diseases from each soybean producing state in the United States during 2011. The purpose was to provide this information to help agencies like the United Soybean Board (USB) decide which research projects to support and to aid scientists in focusing and coordinating research efforts.

**Research Approach and Procedures:**

Plant pathologists from each soybean producing state were contacted in October 2011 and asked for their estimates of the percent soybean yields were suppressed by individual diseases in their state during 2011. These pathologists used field surveys, plant disease diagnostic clinic samples, variety trial data, and research plot data to estimate soybean losses to disease. Most pathologists used several of these methods and consulted with their colleagues to develop an estimate. Loss estimates were presented separately for each state in the northern and southern regions of the United States. The regions are segregated because diseases and the genetics of soybean tend to differ between them.

**Results:**

Diseases suppressed soybean production in the southern (Table 1) and northern (Table 2) United States (U.S.). The top three diseases/pathogens that affected soybean production in the southern U.S. were charcoal rot (11.3 million bushels), soybean cyst nematode (5.1 million bushels), and root knot nematode (4.2 million bushels). The top three diseases/pathogens that affected soybean production in the northern U.S. were soybean cyst nematode (92.1 million bushels), seedling diseases (45.9 million bushels), and Phytophthora root and stem rot (34.8 million bushels). When data from both the northern and southern U.S. were combined, the top three diseases/pathogens that affected soybean production were soybean cyst nematode (97.3 million bushels), seedling diseases (47.0 million bushels), and charcoal rot (41.7 million bushels) (Table 3). In addition to these three diseases/pathogens, two others suppressed yields by at least 20 million bushels and were Phytophthora root and stem rot (34.9 million bushels) and sudden death syndrome (21.9 million bushels).

A database of soybean yield suppression caused by diseases/pathogens collected from 1996 to 2011 has been compiled, and this database is currently being evaluated to determine trends across years. The initial analysis of this database focused on the soybean cyst nematode. The soybean cyst nematode has been ranked as the #1 soybean/pathogen disease in the U.S. since 1996. However, over time, the percentage of loss has decreased from 5-10% in the late 1990’s to 3-4% more recently. In Figure 1, production year is graphed on the x-axis with the losses in bushels annually. There is a negative relationship observed, with a decrease of 8,020,000 bushels per year. This is probably due to a combination of improved soybean varieties with resistance to soybean cyst nematode as well as the improved efforts to discuss this disease on a national level (i.e., via extension channels directly supported by the different check-offs). Nonetheless, this does not necessarily tell the whole story. In Figure 2, soybean loss (in bushels, x-axis) is plotted with the losses in $’s. There is a moderate relationship between these two factors, as shown by the regression line. For every 1 bushel loss, there is a $5.60 increase in the amount lost to soybean cyst nematode. This is a moderate relationship is that there is still a large amount of the variation in soybean loss accounted for. Some of this can be explained by the variation in soybean prices relative to production losses. For example, if we examine the last four commodity years, the losses in terms of $’s would rank as the #1, 6, 7, and 5 years, respectively, even though the actual estimated loss is relatively lower. The #2, 3, and 4 years were 1996 to 1998, respectively. Continued analyses of other diseases in the large database will be a focus in future projects.

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|  | **Table 1. Estimated reduction of soybean yields (bushels) due to diseases for 15 southern states during 2011** | | | | | | | | | | | | | | | |
| **Disease** | **AL** | **AR** | **DE** | **FL** | **GA** | **KY** | **LA** | **MD** | **MS** | **NC** | **OK** | **SC** | **TN** | **TX** | **VA** | **TOTAL** |
| Anthracnose | 52,480 | 409,086 | 21,570 | 0 | 8,079 | 121,121 | 36,489 | 0 | 0 | 4,299 | 0 | 9,810 | 466,908 | 0 | 46,204 | 1,176,047 |
| Bacterial Diseases | 0 | 1,364 | 72 | 1,137 | 0 | 6,056 | 0 | 0 | 0 | 85,976 | 3,615 | 4,905 | 0 | 0 | 2,310 | 105,435 |
| Septoria Brown Spot | 0 | 1,364 | 72 | 0 | 0 | 181,681 | 0 | 1,821 | 38,593 | 128,964 | 0 | 14,716 | 933,816 | 0 | 46,204 | 1,347,229 |
| Brown Stem Rot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,867,632 | 0 | 23,102 | 1,890,733 |
| Charcoal Rot | 262,399 | 6,136,296 | 323,556 | 2,274 | 8,079 | 726,723 | 729,787 | 9,105 | 2,315,558 | 214,940 | 108,447 | 9,810 | 466,908 | 0 | 2,310 | 11,316,193 |
| Diaporthe/Phomopsis complex (seed rot) | 52,480 | 4,091 | 216 | 2,274 | 16,159 | 181,681 | 36,489 | 0 | 38,593 | 21,494 | 0 | 29,431 | 0 | 0 | 23,102 | 406,009 |
| Downy Mildew | 0 | 1,364 | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9,810 | 1,400,724 | 0 | 0 | 1,411,970 |
| Frogeye Leaf Spot (Cercospora sojina) | 0 | 40,909 | 2,157 | 4,547 | 0 | 6,056 | 36,489 | 0 | 77,185 | 0 | 0 | 19,621 | 0 | 0 | 0 | 186,964 |
| Fusarium Wilt & Root Rot | 0 | 1,364 | 72 | 2,274 | 0 | 6,056 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9,765 |
| Other Diseases | 0 | 28,636 | 1,510 | 0 | 0 | 0 | 0 | 0 | 3,087,411 | 85,976 | 0 | 9,810 | 0 | 0 | 115,509 | 3,328,852 |
| Phytophthora Root & Stem Rot | 0 | 1,364 | 72 | 0 | 0 | 6,056 | 36,489 | 0 | 0 | 12,896 | 0 | 0 | 4,669 | 0 | 0 | 61,546 |
| Pod and Stem Blight | 0 | 68,181 | 3,595 | 2,274 | 48,477 | 363,362 | 36,489 | 3,642 | 19,296 | 257,929 | 3,615 | 14,716 | 46,691 | 0 | 23,102 | 891,367 |
| Purple Stain (Cercospora kikuchii) | 104,960 | 136,362 | 7,190 | 0 | 0 | 6,056 | 109,468 | 18,209 | 77,185 | 42,988 | 0 | 29,431 | 0 | 0 | 115,509 | 647,358 |
| Rhizoctonia Aerial Blight | 52,480 | 317,724 | 16,753 | 4,547 | 0 | 0 | 36,489 | 0 | 771,853 | 0 | 0 | 294,310 | 933,816 | 0 | 2,310 | 2,430,282 |
| Sclerotinia stem rot (White Mold) | 0 | 0 | 0 | 1,137 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,669 | 0 | 0 | 5,806 |
| Seedling Diseases | 52,480 | 13,636 | 719 | 0 | 3,232 | 0 | 0 | 0 | 77,185 | 128,964 | 18,075 | 10,791 | 4,669 | 0 | 693,053 | 1,002,805 |
| Southern Blight (Sclerotium rolfsii) | 26,240 | 20,454 | 1,079 | 0 | 16,159 | 0 | 0 | 0 | 19,296 | 42,988 | 0 | 245,258 | 0 | 0 | 346,527 | 718,001 |
| Soybean Rust | 0 | 0 | 0 | 1,137 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 93,382 | 0 | 115,509 | 210,027 |
| Soybean Cyst Nematode | 52,480 | 2,454,519 | 129,422 | 0 | 0 | 1,211,206 | 36,489 | 182,091 | 77,185 | 859,762 | 36,149 | 98,103 | 0 | 0 | 0 | 5,137,406 |
| Root Knot Nematode | 52,480 | 2,454,519 | 129,422 | 0 | 113,112 | 0 | 729,787 | 91,045 | 77,185 | 128,964 | 0 | 0 | 466,908 | 0 | 0 | 4,243,423 |
| Other Nematodes (please list) | 26,240 | 1,364 | 72 | 0 | 48,477 | 0 | 364,894 | 0 | 154,371 | 85,976 | 0 | 9,810 | 0 | 0 | 69,305 | 760,508 |
| Stem Canker | 0 | 1,364 | 72 | 1,137 | 0 | 6,056 | 0 | 0 | 77,185 | 0 | 0 | 0 | 0 | 0 | 2,310 | 88,124 |
| Sudden Death Syndrome | 0 | 6,818 | 360 | 0 | 0 | 12,112 | 0 | 0 | 77,185 | 0 | 0 | 0 | 0 | 0 | 2,310 | 98,785 |
| Virus Diseases | 26,240 | 1,364 | 72 | 0 | 0 | 6,056 | 0 | 182 | 0 | 85,976 | 0 | 0 | 0 | 0 | 23,102 | 142,991 |
| **TOTAL FOR ALL DISEASES** | 760,957 | 12,102,140 | 638,123 | 22,737 | 261,774 | 2,840,277 | 2,189,362 | 306,095 | 6,985,267 | 2,188,094 | 169,900 | 810,334 | 6,690,790 | 0 | 1,651,777 | 37,617,626 |

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|  | **Table 2. Estimated reduction of soybean yields (bushels) due to diseases for 13 northern states during 2011** | | | | | | | | | | | | | |
| **Disease** | **IA** | **IL** | **IN** | **KS** | **MI** | **MN** | **MO** | **ND** | **NE** | **OH** | **PA** | **SD** | **WI** | **TOTAL** |
| Anthracnose | 0 | 2,292,052 | 251,638 | 0 | 794,786 | 0 | 0 | 0 | 0 | 0 | 563,660 | 0 | 481,046 | 4,383,182 |
| Bacterial Diseases | 490,131 | 229,205 | 503,277 | 0 | 3,179,143 | 0 | 0 | 0 | 540,438 | 0 | 140,915 | 0 | 481,046 | 5,564,156 |
| Septoria Brown Spot | 2,450,657 | 2,292,052 | 754,915 | 0 | 6,358,287 | 0 | 0 | 0 | 2,702,190 | 23,753 | 1,127,320 | 1,751,047 | 481,046 | 17,941,266 |
| Brown Stem Rot | 0 | 458,410 | 503,277 | 0 | 158,957 | 6,322,105 | 0 | 0 | 54,044 | 0 | 140,915 | 3,502,093 | 2,886,275 | 14,026,076 |
| Charcoal Rot | 490,131 | 9,168,208 | 2,516,385 | 5,688,905 | 4,768,715 | 0 | 1,002,641 | 0 | 270,219 | 2,375,264 | 140,915 | 3,502,093 | 481,046 | 30,404,523 |
| Diaporthe / Phomopsis complex (seed rot) | 0 | 458,410 | 503,277 | 0 | 794,786 | 0 | 0 | 0 | 27,022 | 0 | 1,127,320 | 0 | 481,046 | 3,391,861 |
| Downy Mildew | 0 | 916,821 | 251,638 | 0 | 794,786 | 0 | 0 | 0 | 27,022 | 0 | 563,660 | 0 | 481,046 | 3,034,973 |
| Frogeye Leaf Spot (Cercospora sojina) | 490,131 | 1,833,642 | 754,915 | 1,138 | 158,957 | 0 | 401,057 | 0 | 1,351,095 | 0 | 140,915 | 0 | 481,046 | 5,612,896 |
| Fusarium Wilt & Root Rot | 490,131 | 1,375,231 | 251,638 | 11,378 | 7,947,858 | 4,741,579 | 0 | 0 | 27,022 | 0 | 140,915 | 0 | 1,443,137 | 16,428,890 |
| Other Diseases (please list) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Phytophthora Root & Stem Rot | 980,263 | 2,292,052 | 754,915 | 0 | 3,179,143 | 3,161,053 | 3,007,924 | 6,645,514 | 810,657 | 7,125,793 | 140,915 | 5,253,140 | 1,443,137 | 34,794,505 |
| Pod and Stem Blight | 490,131 | 916,821 | 251,638 | 0 | 4,768,715 | 1,264,421 | 0 | 0 | 27,022 | 0 | 140,915 | 0 | 481,046 | 8,340,710 |
| Purple Stain (Cercospora kikuchii) | 490,131 | 45,841 | 754,915 | 0 | 1,589,572 | 0 | 0 | 0 | 27,022 | 0 | 281,830 | 0 | 481,046 | 3,670,357 |
| Rhizoctonia Aerial Blight | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 563,660 | 0 | 0 | 563,660 |
| Sclerotinia stem rot (White Mold) | 490,131 | 229,205 | 251,638 | 0 | 6,358,287 | 1,580,526 | 0 | 132,910 | 270,219 | 237,526 | 281,830 | 0 | 1,924,183 | 11,756,457 |
| Seedling Diseases | 1,470,394 | 2,292,052 | 754,915 | 5,688,905 | 7,947,858 | 3,161,053 | 1,002,641 | 13,291,027 | 1,351,095 | 4,750,528 | 563,660 | 1,751,047 | 1,924,183 | 45,949,359 |
| Southern Blight (Sclerotium rolfsii) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Soybean Rust | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Soybean Cyst Nematode | 14,703,943 | 11,460,260 | 3,271,300 | 1,137,781 | 14,306,145 | 18,966,316 | 5,013,207 | 265,821 | 4,053,285 | 7,125,793 | 0 | 7,004,186 | 4,810,458 | 92,118,494 |
| Root Knot Nematode | 0 | 229,205 | 0 | 0 | 0 | 0 | 100,264 | 0 | 0 | 0 | 0 | 0 | 0 | 329,469 |
| Other Nematodes (please list) | 0 | 0 | 0 | 0 | 158,957 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 481,046 | 640,003 |
| Stem Canker | 490,131 | 458,410 | 251,638 | 0 | 794,786 | 316,105 | 0 | 0 | 2,702 | 0 | 0 | 1,751,047 | 1,924,183 | 5,989,003 |
| Sudden Death Syndrome | 490,131 | 4,584,104 | 754,915 | 0 | 7,947,858 | 6,322,105 | 200,528 | 0 | 270,219 | 237,526 | 0 | 0 | 962,092 | 21,769,479 |
| Virus Diseases (please list) | 0 | 458,410 | 251,638 | 0 | 1,589,572 | 0 | 0 | 0 | 2,702 | 238 | 563,660 | 0 | 481,046 | 3,347,266 |
| **TOTAL FOR ALL DISEASES** | 24,016,441 | 41,990,392 | 13,588,478 | 12,528,107 | 73,597,169 | 45,835,263 | 10,728,262 | 20,335,272 | 11,813,974 | 21,876,421 | 6,623,007 | 24,514,651 | 22,609,150 | 330,056,586 |

**Table 3. Estimated suppression of soybean yields (bushels) due to diseases for the U. S. A.**

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| **Disease** | **TOTAL** |
| Anthracnose | 5,559,229 |
| Bacterial Diseases | 5,669,591 |
| Septoria Brown Spot | 19,288,495 |
| Brown Stem Rot | 15,916,810 |
| Charcoal Rot | 41,720,716 |
| Diaporthe/Phomopsis complex (seed rot) | 3,797,870 |
| Downy Mildew | 4,446,942 |
| Frogeye Leaf Spot (Cercospora sojina) | 5,799,860 |
| Fusarium Wilt & Root Rot | 16,438,656 |
| Other Diseases (please list) | 3,328,852 |
| Phytophthora Root & Stem Rot | 34,856,052 |
| Pod and Stem Blight | 9,232,077 |
| Purple Stain (Cercospora kikuchii) | 4,317,716 |
| Rhizoctonia Aerial Blight | 2,993,942 |
| Sclerotinia stem rot (White Mold) | 11,762,263 |
| Seedling Diseases | 46,952,164 |
| Southern Blight (Sclerotium rolfsii) | 718,001 |
| Soybean Rust | 210,027 |
| Soybean Cyst Nematode | 97,255,899 |
| Root Knot Nematode | 4,572,892 |
| Other Nematodes (please list) | 1,400,511 |
| Stem Canker | 6,077,127 |
| Sudden Death Syndrome | 21,868,265 |
| Virus Diseases (please list) | 3,490,258 |
| **TOTAL FOR ALL DISEASES** | 367,674,212 |



**Figure 1. Annual soybean loss, measured in bushels, on a national scale plotted against the production year. The straight line represents the simple linear regression line.**