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Using a hill plot technique for evaluating soybean varieties for resistance to sudden death syndrome

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USING A HILL PLOT TECHNIQUE FOR EVALUATING SOYBEAN VARIETIES FOR RESISTANCE TO SUDDEN DEATH SYNDROME

By

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TITLE: USING A HILL PLOT TECHNIQUE FOR EVALUATING SOYBEAN VARIETIES FOR RESISTANCE TO SUDDEN DEATH SYNDROME

MAJOR PROFESSOR: Dr. Jason Bond

Sudden Death Syndrome (SDS), caused by *Fusarium virguliforme* (Aoki), is one of the most important soybean *Glycine max* (L.) Merr, diseases in the Midwest. Management of this disease is possible by planting varieties with resistance to SDS. Variety evaluations rely on large-scale field-testing, which is very labor and time intensive. In addition, many field trials fail due to a lack of sufficient disease pressure. Greenhouse evaluations are used to differentiate between susceptible and resistant varieties, however the results do not always correlate with field ratings of known check varieties. The objective of this study was to evaluate soybean varieties in small-scale hill plots to determine if results correlate to large-scale field trials. A total of 454 commercial varieties ranging in maturity from 0 to 5 were evaluated along with SDS resistant and susceptible check varieties. In each hill plot, 10 seeds and 4 grams of inoculum were planted. The inoculum consisted of sorghum that was infested with *F. virguliforme.* The row spacing for the hill plots was 91 centimeters between rows and 91 centimeters within the row. The varieties were also planted in field trials in three separate geographical locations based on maturity group. In the field trials, plots consisted of two rows that were 3.04 meters long. Each field plot received 2.45 grams of infested sorghum per 30.5 centimeters of row. When plants reached the R1 growth stage, hill plots and field trials

were irrigated at the rate of 2.54 centimeters per week. The disease incidence (DI) and disease severity (DS) was rated in the hill plots at the growth stage V2 to simulate a greenhouse rating and at the growth stage R6 in both hill plots and field locations. Disease index (DX) was calculated as ((DI x DS)/9) was calculated for the field locations. In 2014, the disease pressure was low in the hill plots, but moderate to severe at the field locations. There was no correlation in the disease ratings of the commercial varieties in the hill plots and field trials. There was also no correlation between the hill plots and field trials for the resistant and check varieties. In 2015, there was no disease in the hill plots, and as a result we could not compare to field ratings.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE

INTRODUCTION/LITERATURE REVIEW

Sudden death syndrome (SDS) of soybean [Glycine max (L.) Merr] is a major soil-borne disease caused by *Fusarium virguliforme* (Aoki et al. 2003), formerly known as *Fusarium solani* f. sp. *glycines* (Roy, 1997). The disease was first discovered in 1971 in Arkansas and since then has been confirmed throughout most soybean-growing areas of the United States of America. This disease has become one of the top soybean yield robbers in the United States. Yield losses to SDS are especially dependent upon growth stage at the time of infection, cultivar reaction and the environment (Roy, 1997). From 1999 to 2004, average losses in the U.S. were estimated at 190 million dollars a year (Robertson and Leandro, 2010).

Fusarium virguliforme produces a bluish sporulation (macroconidia) on the taproot and lower stem of severely diseased plants. The fungus resides in the soil and root debris as chlamydospores, which make up the primary inoculum (Roy, K.W., 1997). Sporulation of the pathogen often occurs when root rot is present. Root rot occurs when soils are high in moisture and typically cold, therefore SDS is more favorable in cool and wet soils (Roy, K. W. 1997,Melgar, J., and Roy, K. 1994). Symptoms of SDS increase rapidly during the reproductive growth stages of soybeans, R2 to R5 (Roy, 1997). Symptoms have been seen as early as the middle vegetative (V4) growth stage, but in the northern regions symptoms generally occur in the early reproductive stages, beginning as interveinal chlorosis then progressing to necrosis of the leaves. Under severe conditions complete defoliation of the leaves may occur, along with pod abortion (Hartman et al., 1997; Hartman et al., 1999). Plants with symptoms generally show internal root discoloration including, grayish to reddish brown discoloration beginning near the pith and radiating outward in the vascular tissue and up the stem for a few nodes, with the pith still remaining white (Roy, 1997).

There are several management practices that can minimize yield loss, but there is no single tactic that will eliminate SDS. One of the most effective practices is to plant resistant cultivars. Initially soybean cultivars were not able to manage SDS (Njiti et al., 2002); however host resistance is available in many cultivars today.

Quantitative resistance is controlled by many genes, and generally does not completely protect the plant from becoming infected, but it slows down the infection, which hinders the development of epidemics. The cultivar Forrest has quantitative resistance (Stephens et al., 1993). One or a few genes control qualitative resistance. This kind of resistance prevents the development of epidemics by limiting the initial attack of the inoculum or by reducing the reproduction after the plant has already been infected (Agrios, 1997).

Since SDS is more likely to appear following periods when the soil is wet and cool, a later planting date is ideal so the young plants will not be as vulnerable to the SDS pathogen (Hershman et al., 1990). Deep tillage is a practice that depending on the soils can be beneficial to helping reduce SDS by maintaining the vertical water movement creating better drainage compared to no-till (Vick et al., 2006). Rupe et al. (1997) found that rotation of soybean with wheat or sorghum decreased inoculum densities of F. *virguliforme* compared with continuous planting of susceptible soybean cultivar. However, Xing and Westphal (2009) found that current corn – soybean rotation system is insufficient to reduce the risk for damage by SDS but is vulnerable to the development of severe soil-borne diseases.

Several methods have been used to evaluate soybean varieties for resistance to SDS. The most common method is by field-testing germplasm across environments and years. These trials can be expensive and time consuming, but have been proven to be the most successful method for evaluating disease reaction (Hashmi et al., 2005). Several other methods have been used including growth chambers and greenhouse methods (de Farias Neto et al, 2008; Hashmi. et al., 2005). Numerous inoculation methods have been developed, such as colonized toothpicks (Klingelfuss et al., 2002; Melgar and Roy, 1994), infested sorghum seeds (Hartman et al., 1997; Mueller et al., 2002), infested cornmeal (*Zea mays* L.) (Gray and Achenback, 1996; Njiti et al., 2001), and soil amendments with infested oat (*Avena sativa* L.) seeds (Stevens et al., 1993b; Melgar and Roy, 1994) infested with *F. virguliforme.* The most widely used screening method, is planting germplasm in soil with sorghum infested with *F. virguliforme* (Luckew et al, 2012). De Farias Neto et al. (2008) determined that application of infested sorghum in a layer in planting cones correlated better with field results (*r* ranged from 0.61 to 0.74) than the application of inoculum in furrows in trays. Hashmi et al. (2005) compared three greenhouse assays and found that a layer of inoculum in cones incubated in water baths which controlled the soil temperature, showed the greatest correlation to field symptoms. Luckew et al. (2012) compared an inoculum layer method to the inoculum mixed method and found that the higher inoculum density than traditionally, with the mixed method is reliable. Inoculum mixed method is when you mix your inoculum into the soil and then plant into the infested soil. This study also showed that this method did not correlate well with field ratings, but it allows for an accurate screening of a large number of lines for SDS resistance when plants cannot be grown in the field. This approach would help to reduce the number of lines that have to be planted in the following year's field trials. There is a great need for a reliable evaluation method with the capability to evaluate a large number of germplasm lines. Hill plot methods have some perceived advantages over traditional field trials; such as a greater ease of early planting considering that they are planted by hand, and there is significantly smaller land needs. It is easier to irrigate and there is less seed and inoculum requirements than that of field trials. Hill plots have been used in the breeding and evaluation program of corn (Jones, and Singleton, 1934), cereals (Bonnett, and Bever, 1947; Ross, and Miller, 1955) and sorghums (Swanson, 1948).

The objective of this research was to evaluate soybean varieties in small-scale hill plots to determine if results correlate to large-scale field trials. This was accomplished by evaluating disease incidence and severity of 454 commercial varieties at the R6 growth stage, along with 34 known check varieties, in inoculated hill plots and in field trials.

CHAPTER TWO

MATERIALS & METHODS

The hill plot experiments were conducted in Carbondale, IL. The field variety trials were located in three separate geographical locations in IL at, Manito, Valmeyer, and Shawneetown. Four hundred and fifty-four commercial varieties ranging in maturity from 0-V were evaluated along with SDS resistant and susceptible check varieties. The 34 known check varieties were selected from the several hundred varieties tested in the Southern Illinois University at Carbondale's Commercial SDS Variety Field Testing program (Hashmi et al. 2005). These varieties were represented in three classes of reaction to SDS: resistant, susceptible, and intermediate. In each hill plot, 10 seeds and 4 grams of sorghum infested with *F. virguliforme* were hand planted in a 2.54 centimeters by 2.54 centimeters divot. The row spacing for the hill plots was 91 centimeters between rows and 91 centimeters within the row. Hill plots and field trials were replicated three times in a randomized complete block design. In the field trials, plots consisted of two rows that were 3.04 meters long and 76 centimeters between rows. Each field plot received 2.45 grams of infested sorghum per 30.5 centimeters of row. The plot planter placed inoculated sorghum in the furrow right next to the seed. When plants reached the R1 growth stage, hill plots and field trials were irrigated at the rate of 2.54 centimeters of water per week. Foliar SDS was rated on the 0-9 scale described by Gibson et al. (1994). The disease incidence (DI) and disease severity (DS) was rated in the hill plots at the V2 growth stage to simulate a greenhouse rating and at the R6 growth stage for both the hill plots and field locations. Disease index (DX) was calculated as ((DI x DS)/9) as described by Gibson et al. (1994), for the field trials and the hill plots.

The Mont-1 isolate of *F. virguliforme* was used to produce inoculum. The inoculum was prepared by first soaking white sorghum [*Sorghum bicolor* (L.) Moench] overnight in water. The water was drained and 1361 g was placed in small (29.84 cm x 23.81 cm x 5.87 cm) aluminum tins with a lid crimped on three sides. The tins were autoclaved for four minutes sterilize time and five minutes dry time at 132°C. After autoclaving the lids were crimped on all sides of the tins and cooled for 24 hours before autoclaving for the second time. Twenty grams of potato dextrose broth (PDB) into 1.75 L of distilled water, 80 ml of this solution was placed into 125 ml Erlenmeyer flasks and autoclaved for 35 min at 121°C. After the inoculum was cooled, each flask was inoculated under a sterile transfer hood with 1 cookie (6 mm diameter) from a 1 week old culture of *F. virguliforme* grown on PDA (potato dextrose agar). The *F. virguliforme* was incubated in the PDB solution for four days on a bench top with ambient air temperature and natural light before the tins were infested. The inoculum was incubated for seven days allowing the fungus to grow adequately, and then the sorghum was air dried for three days.

Foliar SDS data agreement from the hill plots and field trials was determined by Spearman's rho (SAS Institute Inc., 2007). A perfect Spearman correlation of +1 or -1 occurs when each of the variables is a perfect monotone function of the other.

CHAPTER THREE

RESULTS

In the field trials, one foliar disease rating for each replication was taken at the R6 soybean growth stage (full seed or full bean). The DI and DS were collected and a foliar DX were calculated for each variety (Table 1). The 34 known check varieties represent three classes of reaction to SDS: resistant, susceptible, and intermediate. The resistant class is represented with a DX = 10 and all genotypes having a lower DX rating. The susceptible class is represented with a DX = 29 and all genotypes with a higher DX rating. The remaining genotypes are classified as intermediate with a DX range of 11 – 28.

In 2014, the Valmeyer field trial had severe disease with a DX range of 0 – 85. For the hill plots a disease rating was collected for each replication and calculated for a final DX score for each commercial variety (Table 2). In 2014, the disease severity was mild with a DX range of 0 – 27. Foliar DX levels of the hill plots were compared to the field trials (Table 3) and there is no agreement between disease ratings from the two environments. The lack of agreement was also observed for the individual maturity groups. One final comparison of the thirty-four known check varieties also revealed a lack of agreement with results from the field trials and hill plots. Overall there is poor agreement between the hill plot and field trial results in 2014. In 2015, there was no disease in the hill plots, so therefore we could not compare them to the field trial data (Table 4).

DISCUSSION

The levels of SDS were inconsistent in the hill plots over the two years of the research. In 2014, disease levels were mild with no disease being observed in 2015 in the hill plots. In 2014, there was approximately 10.16 cm of heavy rainfall shortly after planting the hill plots. This led to an emergence problem, which could have been caused by the heavy rainfall or a combination of inoculum and seed placement. The disease levels at field trial locations were high over the two years of the research.

The comparison of hill plots and field trial ratings in 2014, showing that over all varieties there was no correlation between them with a Spearman's ρ of ($\rho = 0.08$). With the greatest correlation being in the maturity group four late and five early of ($\rho = 0.12$). Hashmi et al. (2005) achieved a correlation of 0.84 between field and green house evaluations using a cone method in a water bath. While De Farias Neto et al. (2008) achieved a correlation of 0.61 between field and greenhouse inoculations using a similar cone method. The main difference between these two methods is that in Hashmi et al. (2005) greater soil temperature control were obtained by the use of a water bath system, whereas De Farias Neto et al. (2008) soil temperature was regulated by the air temperature in the greenhouse.

Disease levels were low in the hill plots in 2014 and with little to no disease in 2015. This could very well be possible considering the different planting dates, planting on May 22 in 2014 and May 5 in 2015. In 2014 hill plots were planted into warmer soils that were very saturated due to near record rainfall at planting. Although the hill plots were planted in early May in 2015 the soils were still warm and more saturated with water due to a very wet spring. As described by Rupe et al. (1993), SDS can be impacted and delay the symptoms when the soil is too saturated for the seed to germinate. With this being said, low disease levels in 2014 and no disease levels in 2015 could possibly be from the soil being too wet and some of the seeds not germinating. When looking at other SDS field trials at the same location of the hill plots in 2015, they also showed very low levels of disease.

With the data collected in this research we cannot conclude that hill plot will not work for evaluating varieties for SDS resistance. Future research using hill plot methods to evaluate resistance of SDS on soybeans need to be evaluated, considering soybean cultivars are being tested in an actual field environment rather than as Hashmi et al. (2005) and De Farias Neto et al. (2008) performed, which are both in controlled environments.

Table 1

Sudden death syndrome rating of commercial varieties in field trials in 2014

Maturity class	**Variety**	**DI R6[a]**	**DS R6[b]**	**Field DX[c]**
3L	Beck 354L4	36.7	1.0	5.0
3L	Beck 358R4	16.7	1.8	3.0
3L	BX 3539 LL	58.3	3.0	29.0
3L	BX 3560 RY	46.7	1.5	14.0
3L	C3511LL	50.0	1.0	7.0
3L	C3555R2	33.3	0.3	4.0
3L	Dyna-Gro S35LS15	18.3	1.7	4.0
3L	Dyna-Gro S35RS75	80.0	1.7	15.0
3L	Dyna-Gro S35RY83	41.7	1.8	12.0
3L	E3520s	3.3	0.3	0.3
3L	E3553	66.7	2.3	25.7
3L	Hayes 1535RR2	53.3	1.7	15.0
3L	K2-3502	1.7	0.3	0.3
3L	M35-A	40.0	1.7	13.7
3L	Roosevelt 1535RR2	5.0	1.0	1.0
3L	Beck 366L4	52.5	1.5	6.0
3L	Beck 368NR	1.7	0.7	0.3
3L	C3650R2	58.3	1.7	16.7
3L	Dyna-Gro 34RY36	21.7	0.7	2.3
3L	Dyna-Gro S36RY24	66.7	1.7	18.3
3L	E3692s	60.0	2.3	16.3
3L	Grant 1536LL	33.3	0.3	3.7
3L	HS 36A42	5.0	0.7	0.7
3L	Jackson 1536RR2	52.5	1.5	11.5
3L	Jefferson 1436LL	36.7	1.3	11.3
3L	Kennedy 1436RR2	66.7	1.2	9.0
3L	M36-A	0.0	0.0	0.0
3L	Monroe 1536LL	6.7	0.7	1.0
3L	PB-3699R2	70.0	1.0	7.7
3L	389F.YC	66.7	1.5	16.7
3L	Baker 3732NRR	10.0	0.8	1.3
3L	Beck 379L4	5.0	0.7	0.7
3L	BX 3771 RY	53.3	2.0	17.7
3L	C3707LL	36.7	1.5	19.0
3L	C3753LL	33.3	1.3	9.3
3L	C3770R2	50.0	1.8	16.7
3L	E3700	86.7	2.2	22.7

Table 1 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
3L	E3782s	50.0	0.8	7.7
3L	E3792	51.7	1.8	14.3
3L	Eisenhower 1537RR2	5.0	0.7	0.7
3L	HS 37A22	50.0	1.0	8.3
3L	HS 37A42	58.3	1.0	6.7
3L	HS 38A32	36.7	0.8	6.0
3L	K2-3702	30.0	1.0	7.0
3L	**LD06-7862 (res)**[d]	15.0	0.7	1.7
3L	LD11-13814R	41.7	1.2	6.3
3L	**LS05-0220 (sus)**[d]	100.0	4.0	44.3
3L	**MAC02-256 (sus)**	40.0	1.7	10.3
3L	Beck 384R2	0.0	0.0	0.0
3L	Beck 389N	46.7	2.2	16.3
3L	BX 3841 LL	28.3	1.7	7.0
3L	C3848	30.0	0.8	5.0
3L	C3884N	40.0	2.2	12.3
3L	Channel 3808R2	83.3	1.7	24.0
3L	Dyna-Gro S38LL54	76.7	1.8	15.0
3L	Dyna-Gro S38RY84	16.7	0.7	3.7
3L	Dyna-Gro SX14238C	1.7	0.3	0.3
3L	Dyna-Gro V388SCN	96.7	3.0	33.0
3L	HS 38L32	50.0	0.8	7.7
3L	**LD09-17123R2 (res)**	3.3	0.3	0.3
3L	LD11-13342Ra	6.7	1.3	1.0
3L	M38NRR	28.3	1.7	5.7
3L	PB-3878R2	20.0	0.8	2.3
3L	**SS01-12900(sus)**	56.7	1.3	6.3
3L	Truman 1438LL	13.3	1.0	2.3
3L	Washington 1438RR2	35.0	1.5	13.3
3L	Beck 394L4	53.3	2.0	15.0
3L	Beck XL 393R4	41.7	1.8	16.0
3L	BX 3945 LL	33.3	0.5	5.7
3L	C3904LL	0.0	0.0	0.0
3L	C3989R2	33.3	0.3	3.7
3L	**CM 396(res)**	21.7	1.2	3.7
3L	Dyna-Gro 32RY39	45.0	1.2	10.7
3L	Dyna-Gro S39RY65	58.3	2.3	20.3
3L	Garfield 1439RR2	60.0	2.7	16.3

Table 1 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
3L	HS 39A22	91.7	2.7	28.3
3L	HS 39A42	10.0	0.7	1.0
3L	HS 39C42	10.0	0.3	1.0
3L	M39-B	51.7	1.8	13.3
3L	Madison 1539LL	33.3	0.7	3.7
3L	**Morgan(sus)**	50.0	1.7	8.3
3L	PB-3906R2	46.7	0.7	5.3
3L	S39-U2	1.7	0.3	0.3
4E	Baker 4052NRR	93.3	2.5	26.3
4E	Beck 401	83.3	1.3	12.7
4E	C4010R2	93.3	1.5	16.0
4E	Denver 1540RR2	46.7	1.3	6.3
4E	Dyna-Gro S40LL35	100.0	2.7	29.7
4E	Dyna-Gro S40RY25	100.0	3.0	33.0
4E	Dyna-Gro S40RY73	100.0	3.0	33.0
4E	E4000	91.7	3.0	31.0
4E	**Ripley(res)**	8.3	0.7	1.0
4E	AG4135	100.0	2.8	31.7
4E	Beck 418NR	70.0	2.5	23.0
4E	Beck 419L4	100.0	2.8	31.3
4E	BX 4105 LL	80.0	2.3	22.3
4E	BX 4181 RY	100.0	3.7	40.7
4E	C4100LL	100.0	2.8	31.3
4E	C4105N	100.0	3.8	42.7
4E	Dyna-Gro 3410SCN	100.0	3.5	38.7
4E	E4111	83.3	2.2	20.7
4E	E4194	100.0	2.5	27.7
4E	HS 41L42	100.0	2.8	31.3
4E	**MAC02-4757 (sus)**	83.3	6.0	55.7
4E	Norfolk 1541LL	93.3	3.3	35.3
4E	Austin 1342LL	100.0	2.8	31.3
4E	Beck 423NL	96.7	3.7	39.3
4E	Beck 425R4	100.0	3.2	35.3
4E	C4200LL	70.0	1.3	11.3
4E	C4211R2	100.0	3.8	42.3
4E	Dyna-Gro S42LL63	100.0	3.2	35.3
4E	Dyna-Gro S42RS03	100.0	4.0	44.3
4E	E4200	100.0	2.5	27.7

Table 1 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
4E	HS 42A12	100.0	4.0	44.3
4E	**LS04-30080(sus)**	65.0	2.3	21.0
4E	Richmond 1442RR2	100.0	3.8	42.7
4E	**Spencer(sus)**[d]	100.0	6.0	67.0
4E	Stone 2R4204	91.7	2.8	28.7
4E	Baker 4322NRR	90.0	2.8	28.0
4E	Beck 433R2	93.3	3.0	31.3
4E	C4322R2	91.7	2.0	20.0
4E	Dyna-Gro 39RY43	100.0	3.3	36.7
4E	Dyna-Gro S43RY95	100.0	2.8	31.3
4E	E4310s	75.0	3.5	27.7
4E	E4311	100.0	5.5	61.3
4E	E4394	83.3	1.2	11.3
4E	HS 43A42	91.7	2.5	25.0
4E	HS 43C42	86.7	2.8	28.3
4E	Memphis 1243RR2Y	100.0	3.0	33.0
4E	S10-2635	100.0	2.3	26.0
4E	Beck 444NR	100.0	2.7	29.3
4E	Beck 449L4	83.3	1.3	13.0
4E	C4411R2	68.3	1.8	17.0
4E	HS 44L42	61.7	1.3	10.0
4E	**SS03-13390 (sus)**	100.0	4.3	48.0
4E	Stone 2R4415	75.0	1.5	14.0
4L	Baker 4532NSRR	100.0	5.3	59.3
4L	Baker 4552NRR	100.0	2.8	31.3
4L	Beck 459L4	100.0	5.0	55.7
4L	C4544R2	100.0	4.3	48.0
4L	Channel 4508R2/SR	100.0	2.0	22.0
4L	Dyna-Gro 31RY45	100.0	4.5	50.0
4L	Dyna-Gro S45LL33	100.0	5.7	63.3
4L	E4510s	86.7	3.0	27.3
4L	HS 45A12	100.0	2.8	31.3
4L	HS 45A42	100.0	2.7	29.3
4L	Phoenix 1545RR2	100.0	3.2	35.0
4L	**S03-007CR(sus)**	100.0	5.7	63.0
4L	Tampa 1545LL	100.0	2.5	27.7
4L	V11-3392	100.0	7.7	85.3
4L	V11-3522	100.0	6.0	67.0

Table 1 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
4L	V12-0956	100.0	5.0	55.7
4L	Beck XL 465R4	100.0	3.7	40.7
4L	C4696R2	100.0	2.7	29.3
4L	Dyna-Gro S46LL05	100.0	4.5	50.0
4L	Dyna-Gro S46RY85	100.0	3.5	39.0
4L	HBK LL4650	100.0	7.0	78.0
4L	HBK LL4653	100.0	2.3	26.0
4L	HBK RY4620	100.0	3.3	36.7
4L	**LS94-3207 (res)**	100.0	1.0	11.0
4L	Orlando 1346LL	100.0	5.3	59.3
4L	S09-9943	70.0	1.3	10.0
4L	Baker 4732NRR	100.0	2.8	31.3
4L	Beck 475L4	100.0	6.7	74.0
4L	BX 4748 LL	100.0	4.5	50.0
4L	**CM 497 (sus)**	100.0	6.3	70.7
4L	**Douglas (sus)**	100.0	4.3	48.0
4L	Dyna-Gro S47RY13	100.0	2.5	27.7
4L	Dyna-Gro SX14247R	100.0	4.0	44.3
4L	Dyna-Gro SX14847RS	100.0	5.5	61.3
4L	HBK RY4721	100.0	5.0	55.7
4L	HS 47A42	100.0	5.3	59.3
4L	R05-3239	100.0	2.3	26.0
4L	R09-2797	100.0	4.2	46.3
4L	R09-430	100.0	3.3	36.7
4L	R09-4571	100.0	6.0	67.0
4L	AG4835	100.0	3.5	38.7
4L	Baker 4842NSRR	100.0	4.0	44.3
4L	Baker 4852NSRR	100.0	5.3	59.7
4L	Beck 483NL	100.0	5.7	63.3
4L	Beck 485R2	76.7	2.0	18.3
4L	Dyna-Gro S48LL23	100.0	6.7	74.3
4L	Dyna-Gro S48RS53	100.0	5.0	55.7
4L	E4892s	100.0	2.5	27.7
4L	HBK LL4850	100.0	6.5	72.3
4L	HS 48A22	100.0	5.2	57.7
4L	HS 48L22	100.0	7.2	79.7
4L	C4616LL	90.0	2.7	27.3
4L	**Pharaoh(res)**	100.0	2.0	22.3

Table 1 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
4L	S09-10871	100.0	2.5	27.7
4L	S09-6262	100.0	2.8	31.3
4L	Atlanta 1549RR2	100.0	2.2	24.0
4L	Beck 505L4	100.0	5.7	63.0
4L	Beck XL 493R4	100.0	4.0	44.3
4L	Boston 1549LL	100.0	5.7	63.0
4L	BX 4959 RY	100.0	3.5	38.7
4L	C4919R2	100.0	5.5	61.3
4L	C4990LL	100.0	5.0	56.0
4L	Dallas 1549RR2	100.0	4.8	53.7
4L	**DP 4933RR (int)**[d]	100.0	5.3	59.3
4L	Dyna-Gro 33LL49	100.0	5.3	59.7
4L	Dyna-Gro S49LL34	100.0	4.5	49.7
4L	Dyna-Gro S49LS65	100.0	5.7	63.3
4L	Dyna-Gro S49RY25	100.0	3.0	33.3
4L	E4993	100.0	4.7	52.0
4L	HBK LL4950	100.0	5.8	65.0
4L	HBK LL4953	100.0	4.3	48.0
4L	HS 49A42	100.0	5.2	57.7
4L	**LS90-1920(res)**	100.0	1.8	20.3
4L	Miami 1349LL	100.0	4.5	50.0
4L	S11-20356	100.0	1.7	18.3
4L	Tucson 1549LL	100.0	2.3	26.0
5	**850RR (sus)**	100.0	4.0	44.4
5	BX 5150 LL	100.0	5.8	64.8
5	C5122R2	100.0	2.7	29.6
5	E5110	100.0	6.0	66.7
5	BX 5242 LL	100.0	4.8	53.7
5	C5222LL	100.0	4.2	46.3
5	C5252R2	100.0	4.3	48.1
5	**Essex(int)**	100.0	5.2	57.4
5	HBK RY5221	100.0	3.3	37.0
5	**V82-2191(sus)**	100.0	4.7	51.9
5	AG5335	100.0	3.3	37.0
5	**A5403 (int)**	100.0	7.2	79.6
5	C5460R2	100.0	3.8	42.6
5	**Camp (sus)**	100.0	8.0	88.9
5	**DP 5414RR (sus)**	100.0	5.3	59.3

Table 1 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
5	HBK RY5421	100.0	7.0	77.8
5	**A5560 (res)**	100.0	2.3	25.9
5	**Forrest (res)**	100.0	3.2	35.2

[a]Disease Incidence (DI) Rating 0 – 100; 0 = no symptoms in plot, 100% of plants had disease

[b]Disease Severity (DS) Rating scale 0 – 9; 0 = no disease, 9 = complete defoliation

[c]Disease Index (DX) Rating scale 0 – 100; 0 = no disease, 100 = severe disease

[d]SDS resistance classes, (res) = resistant variety DX = 10 and lower, (int) = intermediate variety DX range of 11 – 28, (sus) = susceptible variety DX = 29 and higher.

Table 2

Sudden death syndrome rating of commercial varieties in hill plots in 2014

Maturity class	Variety	DI R6[a]	DS R6[b]	Hill DX R6[c]
3L	Beck 354L4	0.0	0.0	0.0
3L	Beck 358R4	0.0	0.0	0.0
3L	BX 3539 LL	0.0	0.0	0.0
3L	BX 3560 RY	0.0	0.0	0.0
3L	C3511LL	0.0	0.0	0.0
3L	C3555R2	0.0	0.0	0.0
3L	Dyna-Gro S35LS15	0.0	0.0	0.0
3L	Dyna-Gro S35RS75	10.0	0.7	2.2
3L	Dyna-Gro S35RY83	0.0	0.0	0.0
3L	E3520s	0.0	0.0	0.0
3L	E3553	0.0	0.0	0.0
3L	Hayes 1535RR2	3.3	0.3	0.4
3L	K2-3502	0.0	0.0	0.0
3L	M35-A	0.0	0.0	0.0
3L	Roosevelt 1535RR2	0.0	0.0	0.0
3L	Beck 366L4	0.0	0.0	0.0
3L	Beck 368NR	0.0	0.0	0.0
3L	C3650R2	0.0	0.0	0.0
3L	Dyna-Gro 34RY36	0.0	0.0	0.0
3L	Dyna-Gro S36RY24	0.0	0.0	0.0
3L	E3692s	0.0	0.0	0.0
3L	Grant 1536LL	0.0	0.0	0.0
3L	HS 36A42	16.7	0.7	1.9
3L	Jackson 1536RR2	0.0	0.0	0.0
3L	Jefferson 1436LL	0.0	0.0	0.0
3L	Kennedy 1436RR2	16.7	1.3	3.7
3L	M36-A	0.0	0.0	0.0
3L	Monroe 1536LL	6.7	0.7	1.5
3L	PB-3699R2	0.0	0.0	0.0
3L	389F.YC	0.0	0.0	0.0
3L	Baker 3732NRR	6.7	0.7	1.5
3L	Beck 379L4	0.0	0.0	0.0
3L	BX 3771 RY	0.0	0.0	0.0
3L	C3707LL	0.0	0.0	0.0
3L	C3753LL	26.7	1.0	5.9
3L	C3770R2	0.0	0.0	0.0
3L	E3700	0.0	0.0	0.0

Table 2 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Hill DX R6[c]
3L	E3782s	0.0	0.0	0.0
3L	E3792	0.0	0.0	0.0
3L	Eisenhower 1537RR2	0.0	0.0	0.0
3L	HS 37A22	0.0	0.0	0.0
3L	HS 37A42	0.0	0.0	0.0
3L	HS 38A32	0.0	0.0	0.0
3L	K2-3702	16.7	1.0	5.6
3L	**LD06-7862 (res)[d]**	0.0	0.0	0.0
3L	LD11-13814R	0.0	0.0	0.0
3L	**LS05-0220 (sus)[d]**	0.0	0.0	0.0
3L	**MAC02-256 (sus)**	0.0	0.0	0.0
3L	Beck 384R2	13.3	1.0	2.9
3L	Beck 389N	0.0	0.0	0.0
3L	BX 3841 LL	0.0	0.0	0.0
3L	C3848	0.0	0.0	0.0
3L	C3884N	0.0	0.0	0.0
3L	Channel 3808R2	0.0	0.0	0.0
3L	Dyna-Gro S38LL54	0.0	0.0	0.0
3L	Dyna-Gro S38RY84	0.0	0.0	0.0
3L	Dyna-Gro SX14238C	0.0	0.0	0.0
3L	Dyna-Gro V388SCN	0.0	0.0	0.0
3L	HS 38L32	0.0	0.0	0.0
3L	**LD09-17123R2 (res)**	0.0	0.0	0.0
3L	LD11-13342Ra	0.0	0.0	0.0
3L	M38NRR	0.0	0.0	0.0
3L	PB-3878R2	0.0	0.0	0.0
3L	**SS01-12900(sus)**	0.0	0.0	0.0
3L	Truman 1438LL	0.0	0.0	0.0
3L	Washington 1438RR2	0.0	0.0	0.0
3L	Beck 394L4	0.0	0.0	0.0
3L	Beck XL 393R4	0.0	0.0	0.0
3L	BX 3945 LL	0.0	0.0	0.0
3L	C3904LL	0.0	0.0	0.0
3L	C3989R2	0.0	0.0	0.0
3L	**CM 396(res)**	0.0	0.0	0.0
3L	Dyna-Gro 32RY39	0.0	0.0	0.0
3L	Dyna-Gro S39RY65	0.0	0.0	0.0
3L	Garfield 1439RR2	0.0	0.0	0.0

Table 2 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Hill DX R6[c]
3L	HS 39A22	0.0	0.0	0.0
3L	HS 39A42	0.0	0.0	0.0
3L	HS 39C42	0.0	0.0	0.0
3L	M39-B	0.0	0.0	0.0
3L	Madison 1539LL	0.0	0.0	0.0
3L	**Morgan(sus)**	0.0	0.0	0.0
3L	PB-3906R2	0.0	0.0	0.0
3L	S39-U2	0.0	0.0	0.0
4E	Baker 4052NRR	0.0	0.0	0.0
4E	Beck 401	0.0	0.0	0.0
4E	C4010R2	0.0	0.0	0.0
4E	Denver 1540RR2	0.0	0.0	0.0
4E	Dyna-Gro S40LL35	0.0	0.0	0.0
4E	Dyna-Gro S40RY25	0.0	0.0	0.0
4E	Dyna-Gro S40RY73	0.0	0.0	0.0
4E	E4000	0.0	0.0	0.0
4E	**Ripley(res)**	0.0	0.0	0.0
4E	AG4135	0.0	0.0	0.0
4E	Beck 418NR	0.0	0.0	0.0
4E	Beck 419L4	0.0	0.0	0.0
4E	BX 4105 LL	0.0	0.0	0.0
4E	BX 4181 RY	0.0	0.0	0.0
4E	C4100LL	0.0	0.0	0.0
4E	C4105N	0.0	0.0	0.0
4E	Dyna-Gro 3410SCN	0.0	0.0	0.0
4E	E4111	0.0	0.0	0.0
4E	E4194	0.0	0.0	0.0
4E	HS 41L42	0.0	0.0	0.0
4E	**MAC02-4757 (sus)**	0.0	0.0	0.0
4E	Norfolk 1541LL	0.0	0.0	0.0
4E	Austin 1342LL	0.0	0.0	0.0
4E	Beck 423NL	0.0	0.0	0.0
4E	Beck 425R4	0.0	0.0	0.0
4E	C4200LL	0.0	0.0	0.0
4E	C4211R2	0.0	0.0	0.0
4E	Dyna-Gro S42LL63	0.0	0.0	0.0
4E	Dyna-Gro S42RS03	0.0	0.0	0.0
4E	E4200	0.0	0.0	0.0

Table 2 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Hill DX R6[c]
4E	HS 42A12	3.3	0.7	1.1
4E	**LS04-30080(sus)**	0.0	0.0	0.0
4E	Richmond 1442RR2	20	1.0	6.7
4E	**Spencer(sus)**[d]	0.0	0.0	0.0
4E	Stone 2R4204	0.0	0.0	0.0
4E	Baker 4322NRR	0.0	0.0	0.0
4E	Beck 433R2	0.0	0.0	0.0
4E	C4322R2	0.0	0.0	0.0
4E	Dyna-Gro 39RY43	0.0	0.0	0.0
4E	Dyna-Gro S43RY95	0.0	0.0	0.0
4E	E4310s	0.0	0.0	0.0
4E	E4311	0.0	0.0	0.0
4E	E4394	0.0	0.0	0.0
4E	HS 43A42	10.0	0.7	2.2
4E	HS 43C42	0.0	0.0	0.0
4E	Memphis 1243RR2Y	13.3	1.0	2.9
4E	S10-2635	0.0	0.0	0.0
4E	Beck 444NR	10.0	0.7	2.2
4E	Beck 449L4	0.0	0.0	0.0
4E	C4411R2	0.0	0.0	0.0
4E	HS 44L42	0.0	0.0	0.0
4E	**SS03-13390 (sus)**	0.0	0.0	0.0
4E	Stone 2R4415	0.0	0.0	0.0
4L	Baker 4532NSRR	0.0	0.0	0.0
4L	Baker 4552NRR	0.0	0.0	0.0
4L	Beck 459L4	20.0	0.7	6.7
4L	C4544R2	0.0	0.0	0.0
4L	Channel 4508R2/SR	0.0	0.0	0.0
4L	Dyna-Gro 31RY45	0.0	0.0	0.0
4L	Dyna-Gro S45LL33	0.0	0.0	0.0
4L	E4510s	0.0	0.0	0.0
4L	HS 45A12	0.0	0.0	0.0
4L	HS 45A42	16.7	1.0	5.6
4L	Phoenix 1545RR2	0.0	0.0	0.0
4L	**S03-007CR(sus)**	0.0	0.0	0.0
4L	Tampa 1545LL	0.0	0.0	0.0
4L	V11-3392	0.0	0.0	0.0
4L	V11-3522	0.0	0.0	0.0

Table 2 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Hill DX R6[c]
4L	V12-0956	0.0	0.0	0.0
4L	Beck XL 465R4	0.0	0.0	0.0
4L	C4696R2	0.0	0.0	0.0
4L	Dyna-Gro S46LL05	0.0	0.0	0.0
4L	Dyna-Gro S46RY85	11.7	1.3	2.0
4L	HBK LL4650	26.7	1.7	7.8
4L	HBK LL4653	0.0	0.0	0.0
4L	HBK RY4620	0.0	0.0	0.0
4L	**LS94-3207 (res)**	0.0	0.0	0.0
4L	Orlando 1346LL	13.3	0.7	1.5
4L	S09-9943	0.0	0.0	0.0
4L	Baker 4732NRR	0.0	0.0	0.0
4L	Beck 475L4	6.7	1.0	2.2
4L	BX 4748 LL	13.3	1.0	4.4
4L	**CM 497 (sus)**	0.0	0.0	0.0
4L	**Douglas (sus)**	0.0	0.0	0.0
4L	Dyna-Gro S47RY13	13.3	1.0	2.9
4L	Dyna-Gro SX14247R	0.0	0.0	0.0
4L	Dyna-Gro SX14847RS	6.7	0.7	1.5
4L	HBK RY4721	3.3	0.7	1.1
4L	HS 47A42	0.0	0.0	0.0
4L	R05-3239	0.0	0.0	0.0
4L	R09-2797	0.0	0.0	0.0
4L	R09-430	0.0	0.0	0.0
4L	R09-4571	0.0	0.0	0.0
4L	AG4835	0.0	0.0	0.0
4L	Baker 4842NSRR	0.0	0.0	0.0
4L	Baker 4852NSRR	0.0	0.0	0.0
4L	Beck 483NL	0.0	0.0	0.0
4L	Beck 485R2	0.0	0.0	0.0
4L	Dyna-Gro S48LL23	0.0	0.0	0.0
4L	Dyna-Gro S48RS53	0.0	0.0	0.0
4L	E4892s	0.0	0.0	0.0
4L	HBK LL4850	0.0	0.0	0.0
4L	HS 48A22	0.0	0.0	0.0
4L	HS 48L22	0.0	0.0	0.0
4L	C4616LL	0.0	0.0	0.0
4L	**Pharaoh(res)**	0.0	0.0	0.0

Table 2 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Hill DX R6[c]
4L	S09-10871	0.0	0.0	0.0
4L	S09-6262	0.0	0.0	0.0
4L	Atlanta 1549RR2	0.0	0.0	0.0
4L	Beck 505L4	0.0	0.0	0.0
4L	Beck XL 493R4	0.0	0.0	0.0
4L	Boston 1549LL	0.0	0.0	0.0
4L	BX 4959 RY	0.0	0.0	0.0
4L	C4919R2	0.0	0.0	0.0
4L	C4990LL	3.3	0.3	1.1
4L	Dallas 1549RR2	0.0	0.0	0.0
4L	**DP 4933RR (int)**[d]	0.0	0.0	0.0
4L	Dyna-Gro 33LL49	3.3	0.3	1.1
4L	Dyna-Gro S49LL34	0.0	0.0	0.0
4L	Dyna-Gro S49LS65	0.0	0.0	0.0
4L	Dyna-Gro S49RY25	0.0	0.0	0.0
4L	E4993	0.0	0.0	0.0
4L	HBK LL4950	0.0	0.0	0.0
4L	HBK LL4953	6.7	0.7	1.5
4L	HS 49A42	0.0	0.0	0.0
4L	**LS90-1920(res)**	0.0	0.0	0.0
4L	Miami 1349LL	6.7	0.7	2.2
4L	S11-20356	0.0	0.0	0.0
4L	Tucson 1549LL	6.7	0.3	1.5
5	**850RR (sus)**	0.0	0.0	0.0
5	BX 5150 LL	0.0	0.0	0.0
5	C5122R2	0.0	0.0	0.0
5	E5110	0.0	0.0	0.0
5	BX 5242 LL	10.0	0.7	2.2
5	C5222LL	0.0	0.0	0.0
5	C5252R2	0.0	0.0	0.0
5	**Essex(int)**	0.0	0.0	0.0
5	HBK RY5221	0.0	0.0	0.0
5	**V82-2191(sus)**	0.0	0.0	0.0
5	AG5335	0.0	0.0	0.0
5	**A5403 (int)**	0.0	0.0	0.0
5	C5460R2	0.0	0.0	0.0
5	**Camp (sus)**	0.0	0.0	0.0
5	**DP 5414RR (sus)**	3.3	0.3	1.1

Table 2 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Hill DX R6[c]
5	HBK RY5421	0.0	0.0	0.0
5	**A5560 (res)**	0.0	0.0	0.0
5	**Forrest (res)**	0.0	0.0	0.0

[a]Disease Incidence (DI) Rating 0 – 100; 0 = no symptoms, 100% of plants had disease

[b]Disease Severity (DS) Rating scale 0 – 9; 0 = no disease, 9 = complete defoliation

[c]Disease Index (DX) determined by (DI x DS)/9 on a scale of 0 – 100

[d]SDS resistance classes, (res) = resistant variety DX = 10 and lower, (int) = intermediate variety DX range of 11 – 28, (sus) = susceptible variety DX = 29 and higher.

Table 3

Comparison of hill plot vs. field trial by Spearman's rho 2014

Foliar DX	Spearman's ρ	Prob > p
Hill plot results vs field trial results (all varieties)	0.08	0.03
Hill plot results vs field trial results (MG 3L[a])	0.05	0.39
Hill plot results vs field trial results (MG 4E[ab])	0.06	0.43
Hill plot results vs field trial results (MG 4L[ac])	0.12	0.07
Hill plot results vs field trial results (MG 5E[ad])	0.12	0.38
Hill plot results vs field trial results (Check varieties)	0.05	0.65

[a]MG 3L, MG 4E, MG 4L, MG 5E represent Maturity group 3 late, Maturity group 4 early, Maturity group 4 late, Maturity group 5 early, respectively

Table 4

Sudden death syndrome rating of commercial varieties in field trials in 2015

Maturity class	**Variety**	**DI R6[a]**	**DS R6[b]**	**Field DX[c]**
3L	C3511LL	71.6	1.8	17.2
3L	C3555R2	66.7	2.2	17.4
3L	NK S35-C3 Brand	8.3	1.0	1.5
3L	NK S35-A5 Brand	38.3	1.5	10.4
3L	M35-C	28.3	2.3	6.5
3L	S35RY83	5.0	1.0	0.7
3L	S35LS15	13.3	0.7	1.5
3L	2R3516	5.0	1.0	0.7
3L	354L4	71.7	1.7	15.4
3L	K2-3503	3.3	0.5	0.6
3L	HS 35L42	36.7	1.5	6.1
3L	HS 35A50	3.3	0.3	0.4
3L	AG3536	0.0	0.0	0.0
3L	3509R2	6.7	0.8	1.0
3L	**SS02-15887 (int)**[d]	6.7	0.7	0.7
3L	e3520s	10.0	0.5	1.7
3L	e3575s	5.0	0.8	0.7
3L	C3647R2	20.0	1.5	3.6
3L	PB-3699R2	20.0	0.7	4.4
3L	S34RY36	1.7	0.3	0.2
3L	2R3604	61.7	1.7	12.8
3L	BECK 365R2	3.3	0.3	0.4
3L	366L4	13.3	0.3	1.5
3L	HS 36A50	18.3	0.8	2.8
3L	Kennedy 1636RR2Y	10.0	2.0	2.2
3L	Monroe 1536LL	68.3	1.3	11.3
3L	AG3634	5.0	2.0	1.7
3L	**SS02-15897 (int)**	0.0	0.0	0.0
3L	e3692s	41.7	2.5	14.6
3L	389F.YC	51.7	1.8	9.6
3L	Baker 3732NRR	50.0	1.5	9.7
3L	C3753LL	65.0	2.0	14.6
3L	C3770R2	25.0	1.5	6.7
3L	NK S37-Z8 Brand	3.3	0.5	0.6
3L	PB-3766R2	40.0	1.8	6.7
3L	S37RS96	11.7	1.2	1.4
3L	379L4	31.7	1.2	6.8

Table 4 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
3L	K2-3702	1.7	0.3	0.2
3L	HS 37A42	28.3	1.3	3.9
3L	Grant 1537LL	45.0	2.2	13.2
3L	3707R2/SR	26.7	1.3	4.8
3L	3709R2	5.0	0.5	0.8
3L	**LD06-7862 (res)**[d]	5.0	1.3	0.9
3L	**LS05-0220 (sus)**[d]	100.0	3.3	37.0
3L	**MAC02-256 (sus)**	30.0	2.3	9.5
3L	e3782s	45.0	1.5	8.9
3L	LD11-13814R	10.0	1.3	3.0
3L	C3848	18.3	1.3	3.1
3L	PB-3849R2	8.3	1.0	1.3
3L	PB-3878R2	6.7	1.3	0.9
3L	S38RY84	43.3	1.5	6.9
3L	S38RY56	40.0	2.0	7.2
3L	S38LL54	3.3	0.3	0.4
3L	S3805N	26.7	1.0	3.0
3L	2R3801	86.7	2.2	20.4
3L	BECK 387R4	3.3	1.3	0.7
3L	389N	46.7	1.3	6.7
3L	K2-3802	23.3	1.3	3.6
3L	HS 38L32	15.0	0.7	1.7
3L	HS 38A50	26.7	1.0	3.3
3L	Washington 1638RR2Y	46.7	2.2	13.3
3L	Truman 1438LL	8.3	0.7	0.9
3L	AG3832	5.0	0.7	0.6
3L	3808R2	56.7	1.8	11.1
3L	**SS01-12900 (sus)**	70.0	2.5	21.1
3L	e3865s	93.3	2.5	25.6
3L	LD11-13342Ra	1.7	0.3	0.2
3L	C3900	50.0	1.5	13.0
3L	C3904LL	10.0	1.5	1.7
3L	C3989R2	3.3	0.5	0.6
3L	C3915R2	0.0	0.0	0.0
3L	NK S39-C4 Brand	5.0	0.7	0.6
3L	NK S39-U2 Brand	5.0	0.8	0.6
3L	NK S39-T3 Brand	53.3	2.2	11.9
3L	M39B	3.3	0.7	0.4

Table 4 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
3L	PB-3956R2	1.7	1.0	0.6
3L	32RY39	11.7	1.2	2.3
3L	S39RY65	70.0	2.2	17.4
3L	2R3904	0.0	0.0	0.0
3L	2R3906	0.0	0.0	0.0
3L	BECK 393R4	65.0	2.2	12.8
3L	394L4	20.0	0.7	4.4
3L	HS 39A22	85.0	2.8	26.5
3L	HS 39A42	1.7	1.0	0.6
3L	HS 39C42	75.0	2.7	21.3
3L	Madison 1539LL	83.3	2.0	18.1
3L	AG3936	1.7	0.3	0.2
3L	**Morgan (sus)**	100.0	3.2	35.2
3L	e3975	58.3	1.7	12.8
4E	Baker 4052NRR	6.7	1.0	1.3
4E	C4010R2	3.3	0.3	0.4
4E	S40RY25	3.3	0.3	0.4
4E	S40LL35	40.0	1.3	7.0
4E	2R4003	65.0	2.2	18.3
4E	HS 40A50	0.0	0.0	0.0
4E	AG4034	48.3	2.0	10.2
4E	4009R2	1.7	1.0	0.6
4E	**Ripley (res)**	1.7	0.3	0.2
4E	C4100LL	38.3	2.0	10.2
4E	PB-4186R2	68.3	2.7	19.1
4E	3410SCN	26.7	0.7	3.0
4E	419L4	21.7	1.0	2.6
4E	HS 41L42	73.3	1.3	10.7
4E	HS 41A50	23.3	1.3	3.7
4E	Norfolk 1541LL	56.7	2.0	14.4
4E	AG4135	38.3	1.3	9.8
4E	4107R2	55.0	1.5	11.7
4E	**MAC02-4757 (sus)**	90.0	2.7	28.0
4E	e4194	10.0	0.3	1.1
4E	C4211R2	65.0	1.5	11.9
4E	C4221R2	35.0	2.5	12.7
4E	S42RS03	93.3	2.5	25.9
4E	S42RY46	11.7	2.0	2.8

Table 4 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
4E	S42LL63	46.7	1.5	10.7
4E	2R4204	46.7	1.0	8.9
4E	HS 42A12	25.0	2.3	7.6
4E	HS 42A50	40.0	1.2	6.3
4E	Richmond 1442RR2Y	50.0	2.0	13.5
4E	Austin 1642LL	13.3	1.7	3.0
4E	AG4232	30.0	2.0	5.6
4E	4209R2	16.7	0.7	1.9
4E	**LS04-30080 (sus)**	73.3	1.8	17.4
4E	**Spencer (sus)**	100.0	4.3	48.1
4E	Baker 4322NRR	60.0	1.2	11.9
4E	C4322R2	38.3	1.2	6.7
4E	NK S43-K1 Brand	50.0	2.3	12.9
4E	39RY43	51.7	1.7	9.4
4E	S43RY95	33.3	1.7	6.9
4E	2R4302	40.0	1.3	5.4
4E	431N	26.7	2.8	8.3
4E	HS 43C42	53.3	1.7	15.6
4E	HS 43A42	71.7	1.8	17.2
4E	Memphis 1243RR2Y	18.3	1.0	3.5
4E	AG4336	25.0	1.8	8.3
4E	e4310s	36.7	1.0	4.1
4E	e4394	28.3	0.7	3.1
4E	C4411R2	11.7	0.7	1.3
4E	S44LS76	58.3	1.5	14.4
4E	2R4415-SR	8.3	0.8	1.2
4E	449L4	13.3	0.7	1.5
4E	HS 44L42	8.3	0.7	0.9
4L	Baker 4532NRRSTS	58.3	2.8	21.2
4L	Baker 4552NRR	76.7	2.2	21.5
4L	C4585LL	70.0	2.3	19.3
4L	C4544R2	100.0	2.3	25.9
4L	NK S45-R7 Brand	71.7	1.0	8.0
4L	HBK LL4850	100.0	4.0	44.4
4L	31RY45	73.3	1.5	12.2
4L	2R4500STS	100.0	2.5	27.8
4L	2R4516	100.0	2.5	27.8
4L	BECK 453R4	70.0	3.5	22.2

Table 4 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
4L	454L4	50.0	2.0	10.7
4L	HS 45A42	100.0	2.0	22.2
4L	HS 45A50	93.3	1.5	15.6
4L	Phoenix 1545RR2Y	61.7	2.2	15.6
4L	Tulsa 1545LL	100.0	2.7	29.6
4L	AG4533	68.3	2.8	20.9
4L	4508R2/SR	63.3	1.5	10.1
4L	**S03-007CR (sus)**	100.0	3.0	33.3
4L	e4510s	93.3	2.2	23.0
4L	C4696R2	56.7	0.8	7.6
4L	HBK LL4653	43.3	1.5	10.4
4L	S46RY85	70.0	1.3	10.7
4L	S46LL05	68.3	2.0	18.7
4L	BECK 465R4	86.7	1.8	18.1
4L	HS 46A50	95.0	3.7	39.4
4L	AG4632	100.0	3.7	40.7
4L	**LS94-3207 (res)**	68.3	1.0	7.6
4L	Baker 4732NRR	66.7	1.8	20.4
4L	Baker 4852NRRSTS	100.0	3.2	35.2
4L	C4780R2	100.0	2.7	29.6
4L	CZ 4748 LL	100.0	3.2	35.2
4L	S47RY13	76.7	3.0	25.6
4L	37RY47	96.7	1.7	17.6
4L	2R4903STS	100.0	2.2	24.1
4L	HS 47L50	100.0	3.7	40.7
4L	Nashville 1547RR2Y	100.0	3.2	35.2
4L	Orlando 1647LL	100.0	3.7	40.7
4L	**Douglas (sus)**	100.0	3.2	35.2
4L	**CM 497 (sus)**	100.0	3.8	42.6
4L	e4892s	55.0	1.3	8.3
4L	Baker 4842NRRSTS	91.7	2.3	24.5
4L	C4867R2	100.0	3.3	37.0
4L	CZ 4818 LL	100.0	2.0	22.2
4L	S48RS53	76.7	2.3	22.0
4L	BECK 485R2	40.0	2.3	8.9
4L	483NL	100.0	3.7	40.7
4L	HS 48A22	100.0	2.3	25.9
4L	AG4835	83.3	2.2	22.2

Table 4 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
4L	4806R2/STS	80.0	2.7	23.7
4L	**Pharaoh (res)**	68.3	1.8	16.9
4L	**LS03-4303 (int)**	75.0	1.0	8.3
4L	C4990LL	100.0	2.8	31.5
4L	C4994R2	48.3	1.7	10.0
4L	HBK LL4950	100.0	4.2	46.3
4L	HBK LL4953	100.0	3.0	33.3
4L	S49LL34	100.0	3.5	38.9
4L	S49LS65	100.0	3.7	40.7
4L	2R4915-SR	55.0	1.0	6.1
4L	Atlanta 1549RR2Y	63.3	1.7	11.1
4L	Dallas 1549RR2R	100.0	3.2	35.2
4L	Boston 1549LL	100.0	3.5	38.9
4L	Miami 1349LL	100.0	3.7	40.7
4L	Tucson 1549LL	86.7	2.0	20.7
4L	AG4934	100.0	3.5	38.9
4L	**LS90-1920 (res)**	68.3	1.5	13.1
4L	**DP 4933RR (int)**	100.0	2.8	31.5
4L	e4993	100.0	2.8	31.5
5	C5121LL	100.0	3.7	40.7
5	CZ 5150 LL	100.0	4.0	44.4
5	CZ 5147 LL	80.0	1.5	12.5
5	S51RY45	93.3	1.7	17.4
5	e5110	100.0	4.2	46.3
5	CZ 5242 LL	88.3	3.0	29.4
5	HBK RY5221	100.0	2.2	24.1
5	CZ 5225 LL	96.7	2.2	23.7
5	S52RY75	96.7	2.3	25.0
5	S52LL66	100.0	2.8	31.5
5	522L4	100.0	3.3	37.0
5	**Essex (int)**	100.0	2.8	31.5
5	**V82-2191 (sus)**	96.7	3.0	32.2
5	CZ 5515 LL	96.7	3.0	32.8
5	Whitney 1453LL	95.0	3.7	38.4
5	CZ 5445 LL	100.0	1.7	18.5
5	S54RY43	100.0	2.2	24.1
5	**A5403 (sus)**	98.3	4.3	47.5
5	**Camp (sus)**	100.0	5.7	63.0

Table 4 continued

Maturity class	Variety	DI R6[a]	DS R6[b]	Field DX[c]
5	**DP 5414RR (sus)**	100.0	3.0	33.3
5	32RY55	100.0	2.7	29.6
5	S55LS75	88.3	2.0	19.0
5	**A5560 (res)**	40.0	1.3	6.3
5	**Forrest (res)**	98.3	1.5	16.5

[a]Disease Incidence (DI) Rating 0 – 100; 0 = no symptoms, 100% of plants had disease

[b]Disease Severity (DS) Rating scale 0 – 9; 0 = no disease, 9 = complete defoliation

[c]Disease Index (DX) determined by (DI x DS)/9 on a scale of 0 – 100

[d]SDS resistance classes, (res) = resistant variety DX = 10 and lower, (int) = intermediate variety DX range of 11 – 28, (sus) = susceptible variety DX = 29 and higher.

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