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Using Hybrid Disease Nurseries and Yield Loss Studies to Evaluate Levels of Resistance in Sweet Corn

Common rust caused by *Puccinia sorghi* Schwein., Stewart's wilt caused by *Erwinia stewartii* (Smith) Dye, and northern leaf blight caused by *Exserohilum turcicum* (Pass.) K.J. Leonard & E.G. Suggs are troublesome endemic diseases in many areas of the United States where sweet corn (*Zea mays* L.) is grown (2). These three diseases, along with common smut caused by *Ustilago maydis* (DC.) Corda, maize dwarf mosaic, corn earworm (*Heliothis zea* (Boddie)), and European corn borer (*Ostrinia nubilalis* (Hübner)) are considered by many to be the primary diseases and pests of sweet corn grown in the United States. Other diseases and pests can be important in given years and locations, such as anthracnose leaf blight caused by *Colletotrichum graminicola* (Ces.) G.W. Wils., which is epidemic in the Midwest in some years, and head smut caused by *Sphacelotheca reiliana* (Kühn) Clinton, which is endemic in the Pacific Northwest.

Host resistance is the preferred method of control for most diseases and pests of sweet corn, especially common rust, Stewart's wilt, and northern leaf blight (NLB), because it usually is efficient and cost-effective for growers. Each year a grower has the opportunity to select hybrids with resistance to the diseases the grower believes will be most prevalent. A wide range of reactions to rust, Stewart's wilt, NLB, and other diseases exists among the 300–400 sweet corn hybrids available commercially (1,5,7, 10,11), including resistant reactions that can prevent yield reductions under most conditions in the contiguous United States. Nevertheless, resistant hybrids often lack other characteristics that are more important to specific market segments and therefore are not necessarily preferred. In such cases, elite hybrids with moderate levels of resistance may be favored if they can adequately limit yield losses due to diseases.

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To appreciate the role of resistance in managing diseases of sweet corn, one must understand the diversity of markets within the sweet corn industry and know the important characteristics of hybrids grown for various market segments. This knowledge, combined with disease reactions of specific hybrids and estimates of yield reductions resulting from diseases, can be used to evaluate the levels of resistance necessary to manage diseases.

Types and Uses of Sweet Corn

Sweet corn is grown commercially for three primary uses: processing, shipping, and sale at roadside stands. Most processing corn is canned or frozen soon after harvest. Kernels usually are cut from the cob, although some processing corn is frozen on the cob. Most sweet corn grown for shipping is cooled after harvest and shipped for sale at major retail outlets; such corn may be in cold storage for several days. Corn purchased at roadside stands usually is consumed close to where it is grown and within a day or two after harvest. Hybrids for these uses differ in important characteristics (Fig. 1), including endosperm type, kernel color, maturity, yield, plant type, ease of machine- or hand-harvest, husk protection, husk color, appearance of flag leaves, ear shape, tip fill, kernel-row count, kernel depth, pericarp thickness, and length of harvest period. A hybrid that is particularly well adapted for one use may be unacceptable for another, because a trait that is important in one market segment may be unimportant or undesirable in another.

Sweet corn grown in the contiguous United States can be classified broadly into three types based on endosperm mutation: *sugary (su), sugary enhancer (se)*, and *shrunken-2 (sh2)*. Growers usually prefer one of the endosperm mutants, depending on the needs of their markets. The *shrunken-2* and *sugary enhancer* types, which are relatively new compared with the traditional *sugary* sweet corn, are extremely popular for shipping and for sale at roadside stands because of sweeter taste and/or longer shelf life. For example, *shrunken-2* hybrids are almost the only types grown in Florida for shipping. Conversely, *sugary* sweet corn is preferred by processors who sell to institutions. Preference for yellow, white, or bicolor sweet corn also depends, in part, on how the corn will be used. Preferences for bicolor corn at roadside stands in New England and for yellow corn for processing are traditional.

Resistance or susceptibility to diseases may be among the secondary criteria used to select hybrids, especially if a particular disease is prevalent and is perceived to be economically damaging. A typical case is common rust, which is prevalent in northern Illinois, Wisconsin, and Minnesota in August and September. Rust-resistant hybrids that have excellent traits for processing receive greater consideration for use late in the growing season than do similar hybrids lacking resistance to rust. Conversely, susceptibility to diseases such as common smut may exclude an otherwise acceptable hybrid from consideration.

While several sweet corn hybrids have acceptable levels of resistance to common rust, Stewart's wilt, and NLB, all groups of hybrids adapted for all of the specific market segments are not resistant to these diseases. For example, none of the early-maturing, yellow hybrids grown for processing have adequate

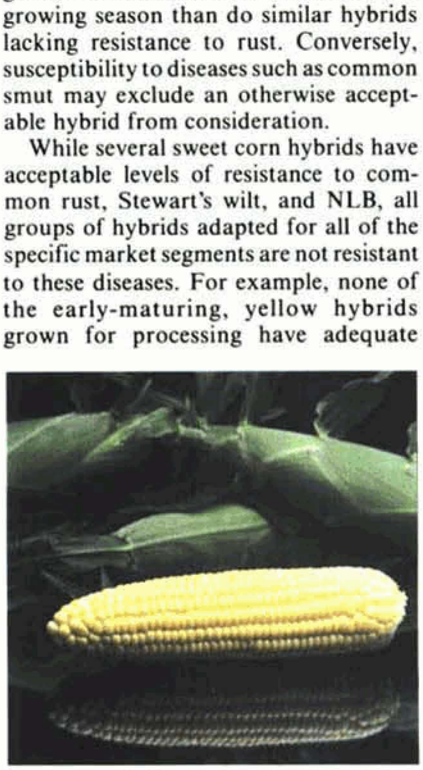

Fig. 1. Ears of sweet corn illustrating some of the important traits: tip fill, kernel-row count, ear shape, husk color, and appearance of flag leaves. (Courtesy Illinois Foundation Seeds, Inc.)

levels of resistance to Stewart's wilt. Resistance to Stewart's wilt is present in some mid- and late-season processing hybrids and in several hybrids grown for other uses. Similarly, very few *shrunken-2* hybrids are resistant to common rust even though several midseason, yellow *sugary enhancer* hybrids have acceptable levels of partial resistance and several midseason, yellow *sugary* hybrids have rust resistance conveyed by single dominant genes (*Rp*-resistance).

Because adequate levels of resistance are not present in hybrids grown for certain market segments, a logical objective is to incorporate resistance into hybrids adapted for these markets. However, breeding sweet corn for higher levels of resistance is a relatively long-term objective. Even though most resistance in maize is highly heritable, several generations of backcrossing and/or several seasons of selection and progeny testing are required. Developing a new resistant inbred takes at least 5–10 years even when resistance is inherited simply. Incorporation of partial resistance from other types of maize (e.g., corn belt dents, tropical cultivars) may require even more time than simply inherited resistance because many of these "exotic" sources have traits that are deleterious to sweet corn quality or adaptability. In addition to the time required, there are "costs" of incorporating resistance in sweet corn. Because most sweet-corn breeding programs have limited resources, resistant inbreds and hybrids often are developed at the expense of improving other important traits.

Because the development of resistant hybrids is a rather lengthy endeavor, a more immediate, pragmatic objective has been to identify the reactions of existing sweet corn hybrids to the prevalent diseases and to relate those reactions to potential reductions in yield. In this way, the value of the moderate levels of resistance currently available can be estimated, and those hybrids can be used to manage diseases until highly resistant hybrids are developed and released. Yield loss information also will allow growers to evaluate the feasibility and necessity of using other disease control tactics when susceptible and moderately susceptible hybrids are grown.

Reactions of Hybrids to Rust, Stewart's Wilt, and NLB

Resistance and susceptibility are the two extremes of a continuum that usually is measured by the amount and type of symptoms observed on the host. In some instances, resistance is controlled by major genes that result in resistant and susceptible phenotypes with qualitative differences, such as *Rp*-resistance to *P. sorghi* and *Ht1* resistance to race 0 of *E. turcicum*. In most situations, the reactions of host genotypes vary continuously, and resistant and susceptible phenotypes differ quantitatively, i.e., in severity of symptoms.

A common method to evaluate resistance is to score the reactions of genotypes after inoculation in a disease nursery. Over 850 sweet corn hybrids have been evaluated for reactions to common rust, Stewart's wilt, and NLB in nurseries at the University of Illinois (7,10,11). The most recent summary is available in the *Midwestern Vegetable Variety Trial Report* for 1992 (7). Separate but identical groups of hybrids are inoculated each year with each of the pathogens. Urediniospores of *P. sorghi* or conidia of races 0 and 1 of *E. turcicum* are sprayed into whorls of plants at the three- to five-leaf stage, and the amount of symptomatic leaf area (disease severity) is rated between the midsilk and fresh-market growth stages. *E. stewartii* is introduced into wounds created by the pinprick method, and plants are rated on a 1–9 scale about 3 weeks after inoculation. Thus, reactions of hybrids to rust and NLB are based primarily on secondary infection, while reactions to Stewart's wilt are based primarily on the systemic movement of *E. stewartii* within a plant. Secondary dispersal of *E. stewartii* from plant to plant is of minor importance in these evaluations.

A wide range of reactions to each disease has been observed each year (Figs. 2, 3, and 4). Disease reactions of hybrids usually follow relatively normal or positively skewed distributions (Figs. 5 and 6). Hybrids are classified as resistant (R), moderately resistant (MR), moderate (M), moderately susceptible (MS), or susceptible (S) on the basis of the variation that occurs among commercially available sweet corn and of the separation of that variation by multiple comparison tests (e.g., BLSD) and standardized z-scores. While this classification produces groups that "overlap" statistically, it is useful for growers because it identifies the potential for severe amounts of disease on particular hybrids. Hybrids classified as susceptible typically have z-scores above 0.8 and are among the worst 10–20% evaluated, whereas hybrids classified as resistant usually have z-scores below -0.8 and are among

Fig. 2. (Left to right) Susceptible, moderate, and resistant reactions of sweet corn hybrids to northern leaf blight caused by *Exserohilum turcicum*.

Fig. 3. (Left to right) Resistant, moderate, and susceptible reactions of sweet corn hybrids to Stewart's wilt caused by *Erwinia stewartii*. During the drought of 1991, symptoms were particularly severe about 1 week before harvest.

Fig. 4. A naturally occurring epidemic of common rust caused by *Puccinia sorghi* on sweet corn hybrids that are susceptible and *Rp*-resistant. (Courtesy David E. Fisher, PictSweet Frozen Foods)

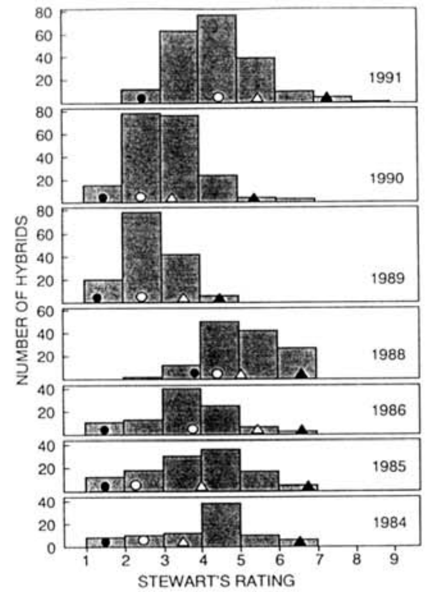

Fig. 5. Distributions of sweet corn hybrids rated from 1 to 9 for reactions to Stewart's wilt in the University of Illinois disease nursery. Hybrids were evaluated at about the seven- to nine-leaf stage, 3 weeks after inoculation. Hybrids included as resistant (●), moderately resistant-resistant (○), moderately susceptible-moderate (△), and susceptible (▲) standards were Honey n Frost, Florida Staysweet, Phenomenal, and Jubilee, respectively.

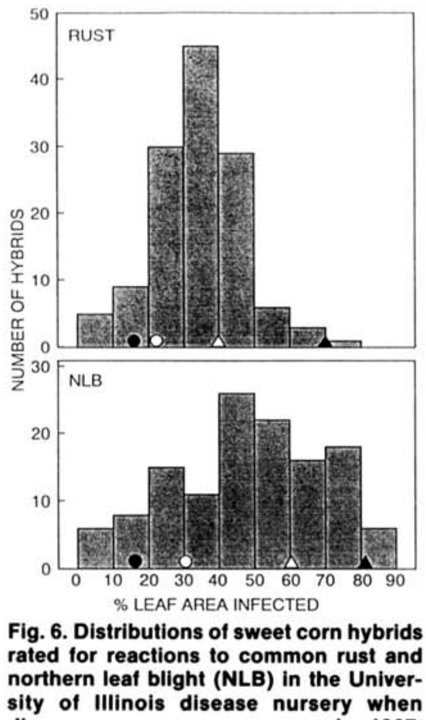

Fig. 6. Distributions of sweet corn hybrids rated for reactions to common rust and northern leaf blight (NLB) in the University of Illinois disease nursery when disease pressure was severe in 1987. Hybrids included as resistant (●), moderately resistant (○), moderately susceptible (△), and susceptible (▲) standards were Miracle, Honey n Frost, Ssuper-Sweet 7200, and Florida Staysweet, respectively, for common rust and Ssuper-Sweet 7200, Honey n Frost, Xtra Sweet 82, and Jubilee, respectively, for NLB.

the best 10–20% evaluated. The moderately resistant and moderately susceptible classes include hybrids that are better and worse, respectively, than average, with z-scores usually ranging from −0.2 to −0.8 and from 0.2 to 0.8, respectively, but are not among the best or worst 10–20%. The moderate class includes hybrids that are within about 10% of the average, with z-scores ranging from about −0.20 to 0.20. These ratings are relative. Although some disease may occur on hybrids classified as resistant, the amount is less than that observed on hybrids classified as moderately resistant, moderate, moderately susceptible, or susceptible.

In order to compare results among years, we include a group of "standard" hybrids (Table 1) in each nursery. By comparing z-scores of the standards from year to year, we can determine if hybrids evaluated in a particular year are more resistant or susceptible than those evaluated in other years or if ranges of severity merely differ from year to year. For example, ranges of Stewart's wilt ratings were very different in 1988 and 1990 (Fig. 5). Hybrids rated from 2.9 to 3.7 were classified as resistant in 1988 but as moderate or moderately susceptible in 1990. Since the z-scores of the standard hybrids were fairly constant in both years (Table 2), the hybrids evaluated in 1990 were not more resistant than those in 1988. Instead, the range of severity differed between 1988 and 1990, probably because of environment.

Hybrids do not always fall into the same resistance category every year, so we prefer to evaluate hybrids for at least 3 years in order to account for random error and other differences that may affect ratings. A hybrid on the borderline between categories may be given a classification of R-MR, S-MS, etc., to indicate that variation was observed over several trials. For example, Florida Staysweet's classification of MR-R for Stewart's wilt reflects 6 years of MR ratings and 2 years of R ratings. Successive ratings within years also can produce "borderline" categories.

Because these categories of reactions are relative, hybrids rated R may not have adequate resistance in certain environments even though they are among the most resistant sweet corn hybrids available. For example, sweet corn hybrids with the best partial resistance to common rust (e.g., Miracle, More, Sweetie 82) do not have adequate levels of resistance to prevent severe epidemics in Hawaii (5; J. L. Brewbaker, *personal communication*). When additional rust resistance is introduced into sweet corn, the z-scores of all current standards will increase, the amount of resistance necessary for a hybrid to be classified as R will increase, and the hybrids currently rated R will be rated closer to average. At that time, a new category, such as highly resistant (HR), can be added for the improved materials or the classification of all hybrids can be revised on the basis of old and new standards.

Although the sweet corn hybrids we classify as resistant may not be as resistant as tropical maize or some of the dent corn hybrids grown in the Midwest corn belt, they usually can prevent severe disease development in most environments where sweet corn is grown in the contiguous United States. Nevertheless, increased levels of partial resistance are needed for certain severe environments where disease pressure is excessive, such as NLB and common rust in Florida and common rust in the northern regions of the Midwest. Under the severe disease pressure in our nursery, hybrids classified as resistant had up to 20% rust severity, 17% NLB severity, and a Stewart's wilt rating of 4.2 (Figs. 5 and 6).

Resistance terminology sometimes presents a minor problem in communicating the results of the hybrid disease nursery. Some growers and seed producers prefer to reserve the term "resistant" strictly for "immune" reactions like that conveyed by the *Rp* genes for *P. sorghi*. Hybrids with partial resistance (quantitative differences in reactions) are sometimes labeled as "tolerant." Few growers or seed producers use the term "tolerant" as did Schafer (12) when he referred to genotypes that sustain less damage under equal levels of disease severity. Instead, seed producers often define tolerance as the ability of a hybrid to perform well (i.e., yield) relative to other hybrids under similar disease environments, in which case the superior performance could be due to partial resistance or "tolerance" sensu Schafer. To avoid confusion, most seed producers define resistance terminology in seed catalogs. We prefer to differentiate the range of quantitative reactions as levels of resistance or susceptibility and to make special reference to qualitative reactions. For example, we use a separate designation for hybrids with *Rp*-resistance to common rust because uredinia do not form on these hybrids and this discontinuous variation is a categorically different class of resistance.

Yield Reductions Associated with Disease Severity

How yield of sweet corn is measured depends on its use. Processors usually measure yield on the basis of weight of kernels cut from the cob, whereas shippers and roadside-stand growers measure yield on the basis of crates of ears or number of ears per hectarage.

In order to determine how much resistance is needed to prevent economic damage, reductions in sweet corn yield have been associated with different amounts of disease severity. Yield was

Table 1. Sweet corn hybrids included as "standards" in the University of Illinois disease nursery

Hybrid	Endosperm type	Disease reaction[a]: Northern leaf blight	Common rust	Stewart's wilt	Seed source
Florida Staysweet	*shrunken-2*	MR-R	S-MS	MR-R	Illinois Foundation Seeds, Inc.
Honey n Frost	*sugary*	MR-R	MR-M	R	SeedWay, Inc.
Jubliee	*sugary*	S	M-MR	S	Rogers NK Seed Co.
Miracle	*sugary enhancer*	R-MR	R-MR	R	Crookham Company
Phenomenal	*shrunken-2*	MR-M	MS-MR	M-MS	Crookham Company
SsuperSweet 7200	*shrunken-2*	R	MS	R	Abbott and Cobb, Inc.
SsuperSweet 7710[b]	*shrunken-2*	R	M	R	Abbott and Cobb, Inc.
Sweetie 82	*shrunken-2*	M	R-MR	MR-M	Sunseeds
Xtra Sweet 82	*shrunken-2*	S-M	S-MS	S-M	Illinois Foundation Seeds, Inc.

[a]Range of response over several trials during 1984–1992. R = resistant, MR = moderately resistant, M = moderate, MS = moderately susceptible, S = susceptible.
[b]SsuperSweet 7710 was added in 1989 to replace SsuperSweet 7200.

Table 2. *Z*-scores[a] for sweet corn hybrids included as "standards" for evaluations of Stewart's wilt in the University of Illinois disease nursery

Hybrid	Reaction[b]	1992	1991	1990	1989	1988	1986	1985	1984
Honey n Frost	R	−0.9	−1.2	−1.8	−1.5	−1.0	−0.9	−1.0	−1.1
Miracle	R	−1.5	−2.4	−1.3	−1.2	−1.5	−0.8	−0.9	−0.2
Florida Staysweet	MR-R	−0.3	−0.7	−0.6	−0.8	−0.6	−0.6	−0.9	−0.5
Sweetie 82	MR-M	−0.3	0	−0.3	−0.4	...	−0.5	−0.5	−0.7
Phenomenal	M-MS	0.6	0	0.1	0.8	−0.2	0.1	0.4	0.7
Jubilee	S	1.3	3.1	2.4	2.1	1.8	1.8	4.1	2.6

[a]Calculated as: [(hybrid rating − grand mean)/standard deviation].
[b]R = resistant, MR = moderately resistant, M = moderate, MS = moderately susceptible, S = susceptible.

Table 3. Estimates of reductions in yield of sweet corn hybrids in the University of Illinois disease nursery

Classification	Estimates of reductions in yield (%)[a]: Common rust	Stewart's wilt	Northern leaf blight
Resistant	0–12	0–4	0–8
Moderately resistant	5–18	4–15	5–10
Moderately susceptible	9–24	8–25	8–25
Susceptible	15–45	>40	12–45

[a]Estimates with common rust are based on severity observed on hybrids in each category multiplied by 0.6%, estimates with Stewart's wilt are based on one or two inoculations at about the five-leaf stage (11), and estimates with northern leaf blight are based on severity observed on hybrids in each category multiplied by 0.5%.

measured in the disease nursery from 1984 to 1986 and regressed on severity (10). These results were variable, but they provided general estimates of losses associated with various levels of resistance (Table 3). Other experiments were designed to provide more precise estimates of yield reductions and were done concurrently with or subsequent to the nursery estimates (3,6,8,13).

Common rust. Yield of sweet corn decreased about 0.6% for each 1% of leaf area infected (severity) when measured about 1 week before fresh market harvest (Fig. 7). Rust has similar effects on ear weight and the total number of marketable ears but does not affect yields of hybrids with *Rp*-resistance. In the disease nursery, rust severity ranged from 1 to 20% on partially resistant hybrids classified as R, which corresponded to potential reductions in yield of about 0–12%. For hybrids classified as MR, severity usually ranged from 8 to 30% and potential reductions were about 5–18%. For hybrids classified as MS, severity ranged from 15 to 40% and potential reductions were about 9–24%. For hybrids classified as S, severity ranged from 25 to 75% and potential reductions were about 15–45%. The actual severity of rust in a given field depends on the environment and inocula at that location. Rust severity may be higher or lower than what has been observed in our disease nursery, but the relative response of R, MR, MS, and S hybrids should remain constant unless

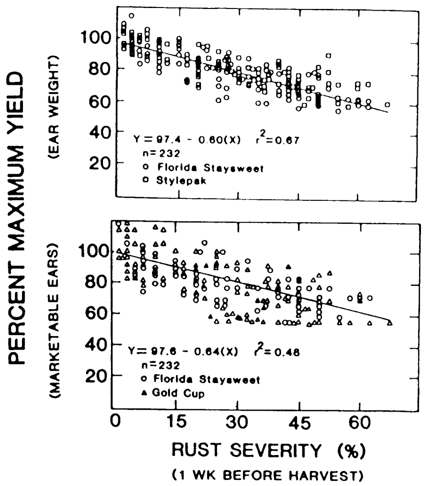

Fig. 7. Relationships between yield of sweet corn and severity of common rust 1 week before harvest (6). Yield is based on ear weight or number of marketable ears.

a genotype × environment interaction affects disease reactions. Also, the rate of rust development is slower on R hybrids than on S hybrids (4). Hence, severe epidemics of rust on R and MR hybrids may be controlled with lower rates, fewer applications, and/or less uniform coverage of fungicides than may be necessary to achieve the same level of control on MS and S hybrids. We recently compared levels of partial resistance and fungicidal control (9).

Table 4. Effects of resistance and plant growth stage on reductions in yield[a] due to Stewart's wilt

	Percent yield reduction based on growth stage at which plants were inoculated		
Hybrid reaction	**Three- to five-leaf**	**Five- to seven-leaf**	**Seven- to nine-leaf**
Resistant	0	0	0
Moderately resistant	0–30	0	0
Moderately susceptible	10–40	0–10	0
Susceptible	40–100	15–35	3–10

[a]Calculated as percentage of noninoculated control treatments (13).

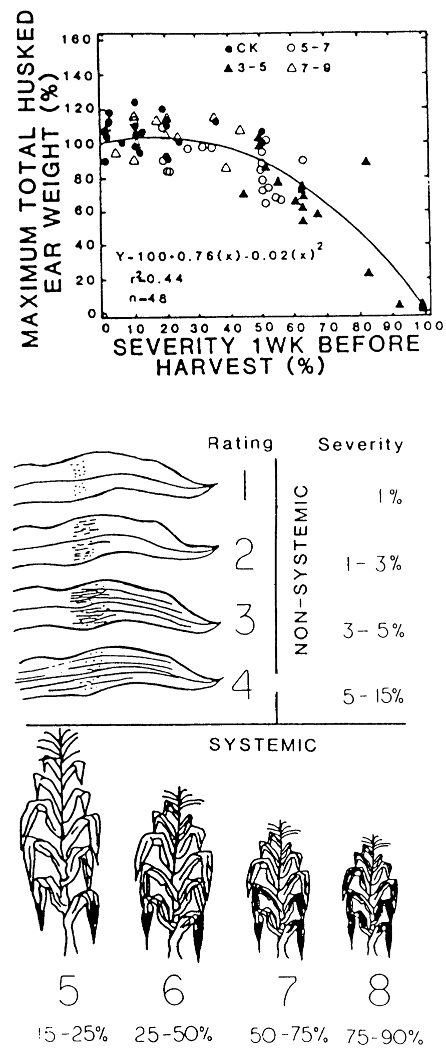

Fig. 8. Relationship between yield of sweet corn, based on ear weight, and severity of Stewart's wilt 1 week before harvest (13); relationships were similar when yield was measured as marketable ears. A threshold of approximately 30–40% severity corresponds to a rating of about 5.5–6 on our 1–9 scale and indicates that *Erwinia stewartii* has moved systemically within the host.

Stewart's wilt. The effects of Stewart's wilt on sweet corn yield depends on the level of host resistance and the growth stage at which plants are infected (13) (Table 4). When plants were infected at about the five-leaf stage in the disease nursery, yield of R hybrids was within 4% of that of noninfected controls, yield of MR hybrids was reduced about 4–15%, yield of MS hybrids was reduced about 8–25%, and yield of S hybrids was reduced by more than 40% (11) (Table 3). In another study (13) in which plants were infected at the three- to five-leaf, five- to seven-leaf, or seven- to nine-leaf stage and compared with a noninfected control, there was a "trade-off" between time of infection and level of resistance (Table 4). In most cases, systemic infection was necessary for Stewart's wilt to reduce yield. When regression analysis was used to evaluate the effect of Stewart's wilt on yield, a threshold of about 30–40% severity was observed when plants were rated about 1 week before harvest. On our 1–9 scale indicating movement of *E. stewartii* in the host, 30–40% severity is equal to a rating of about 5.5–6 (Fig. 8).

Our estimates of yield reductions due to Stewart's wilt are based on the spread of *E. stewartii* within host plants as a result of one or two inoculations. Under severe epidemics, when populations of the corn flea beetle (*Chaetocnema pulicaria* Melsheimer) are large, plants may be inoculated several times by these insect vectors. Consequently, the amount of host tissue infected, the severity of symptoms, and the corresponding reductions in yield may be worse than predicted from our experiments. Nevertheless, the relative response of R, MR, MS, and S hybrids should remain fairly consistent. Also, we have observed a few hybrids, especially those intolerant of stresses (disease, environment, nutrient, etc.), that suffer greater yield reductions from Stewart's wilt than would be predicted from their level of resistance.

NLB. Yield of sweet corn decreases about 0.3–0.7% for each 1% severity of NLB above a threshold of about 8% in the upper 75% of the plant canopy (8). When severity in the upper 75% of the plant is less than 8%, yield is not affected (8). In most years, the yield of hybrids classified as R or R-MR was not affected by NLB (Table 3), whereas the yield of S hybrids was reduced 12–45% when NLB severity reached 23–90%. In the disease nursery, severity of NLB ranged from 1 to 17% on R hybrids, from 10 to 22% on MR hybrids, from 17 to 50% on MS hybrids, and from 23 to 90% on S hybrids. As with rust and Stewart's wilt, the actual severity of NLB in a particular field is specific to that location, but the relative responses of R, MR, MS, and S hybrids should remain fairly constant. During severe epidemics, such as those occurring in the Belle Glade area of Florida, R-MR hybrids may have substantial amounts of NLB and require some applications of fungicides to maintain adequate levels of control. However, as with rust, controlling NLB with fungicides should be easier on R-MR hybrids than on S-MS hybrids.

Because many sweet corn hybrids have *Ht*-resistance, we evaluate hybrids against a combination of races 0 and 1 of *E. turcicum* to identify hybrids carrying the gene *Ht1*. Ratings of NLB severity and classification of reactions of hybrids to NLB are based on both chlorotic (race 0) and necrotic (race 1) lesions. Reductions in yield of S hybrids carrying the gene *Ht1* are substantial even when they are infected only by the avirulent race 0, because of the large reduction of photosynthetic area resulting from chlorotic lesions.

Conclusions and Additional Work

The disease nursery and corresponding yield loss studies have helped identify segments of the sweet corn industry for which levels of resistance usually are adequate and segments for which additional control is necessary. The levels of resistance to Stewart's wilt currently available in some sweet corn hybrids are adequate for the disease pressure that occurs in most of the contiguous United States. Nevertheless, hybrids resistant to Stewart's wilt are not available for all market segments, so breeding efforts should focus on incorporating resistance into other hybrids. *Rp*-resistant hybrids are extremely effective for controlling common rust in the contiguous United States, although new races of *P. sorghi* may develop. Currently, we do not know of sweet corn hybrids with *Rp* genes other than *Rp1d*, even though other *Rp* genes may be effective (2). The levels of partial resistance to common rust that are currently available in sweet corn provide a marginal amount of control under moderate to severe disease pressure. Additional partial resistance to common rust would be useful, especially if virulence occurs against the *Rp* genes. The gene *Ht1* is relatively ineffective for controlling NLB in sweet corn because of the prevalence of race 1 of *E. turcicum*. Other *Ht* genes currently being incorporated in sweet corn may be of little value if other races of *E. turcicum* increase in frequency. The partial resistance to NLB in many sweet corn hybrids is adequate for most situations, but improvement may be needed for severe epidemics.

The responses of hybrids evaluated in the Illinois sweet corn hybrid disease nursery are relative, but rankings should remain constant unless a new strain or race of a pathogen occurs with specific virulence. Likewise, our yield loss estimates are conditional. Yield losses could vary under different environments, but they should remain relative to the resistance or susceptibility of a hybrid. Even though these data are not absolute, they allow growers to compare and rank the resistance of hybrids and corresponding reductions in yield and to evaluate the feasibility and need for other controls.

In recent years, the nursery has been expanded to include other diseases: common smut, anthracnose leaf blight, southern leaf blight caused by *Bipolaris maydis* (Nisikado & Miyake) Shoemaker, southern rust caused by *Puccinia polysora* Underw., and maize dwarf mosaic. Goss's wilt caused by *Clavibacter michiganensis* subsp. *nebraskensis* (Vidaver and Mandel) Davis et al, evaluated from 1984 to 1987, was dropped because it was not prevalent in the principal areas where sweet corn is grown. We will continue to evaluate hybrids and inbreds for reactions to the most prevalent diseases and for diseases with the potential to cause significant problems. Because new hybrids and inbreds are developed constantly, the nursery fulfills a useful function in determining which of these new genotypes might be used to manage diseases.

On the basis of information from the disease nursery, composite populations have been created from resistant and moderately resistant sweet corn hybrids, and recurrent selection for partial resistance to multiple diseases is being done. Also, populations of resistant hybrids from the nursery are being used to develop resistant lines for specific market segments. The success of breeding sweet corn for disease resistance will be evident when hybrids evaluated in the nursery have been improved to the extent that the "standards" are no longer included in their current categories. When this occurs, yields of highly resistant hybrids should not be affected adversely by diseases. The ultimate goal of the cooperative effort between plant pathologists and sweet corn breeders is to develop highly resistant hybrids that are adapted for each of the various market segments of the sweet corn industry.

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