MANAGING CURLY TOP IN SOUTHERN IDAHO

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Curly top of sugarbeets caused by *Beet curly top virus* (BCTV) was widespread from southeastern Oregon to southcentral Idaho in 2004. Curly top first became a serious threat to sugarbeet production in southern Idaho in 1919. By the time the first resistant variety was released in 1935, BCTV had almost eliminated the sugarbeet industry (2). Today this disease is largely managed through the use of resistant varieties. Early planting and the use of systemic insecticides (phorate, aldicarb, and imidicloprid) will also help limit curly top (1,2,4).

The virus is transmitted by the beet leaf hopper, *Circulifer tenellus*, and overwinters in host plants or adult females that survive on mustard species (1). The coldest southern Idaho winters will not eliminate the leaf hoppers. Eggs are laid on leaves and stems in the spring which leads to three broods per year in Idaho. The first brood occurs in the desert prior to spring migration. In southcentral Idaho, migration occurs from May 12 to June 5 with the average peak migration occurring on May 25 (1). The second and third broods occur on sugarbeets and other hosts. Brood development normally takes 1 to 2 months depending on temperature. The leaf hoppers can survive on plants from 19 families and 106 species (1). In the spring the most important hosts are tansy mustard (flixweed) and tumble mustard (Jim Hill mustard). Summer weed hosts include halogeton, kochia, Russian thistle, and bassia. In the fall, the primary weed hosts include Russian thistle and red orache (saltbush). Russian thistle is particularly important since it determines the size of the hibernating population which will survive over the winter on mustards.

Leaf hoppers acquire BCTV by feeding on infected plants. Studies (1) indicate that the percentage of a population of leaf hoppers that will acquire and transmit BTCV increases as feeding time increases (acquisition percentage): 1 min (1.4 – 3.3 %), 2 min (6.7 %), 5 min (26.5 %), 30 min (28 %), 1 hr (44 %), and 4 hr (76 %).

The BCTV can infect plants from over 330 species in 44 families but does not infect monocots (1). In sugarbeet, within 2-10 days of inoculation, symptoms begin to appear as vein clearing. As the disease progresses leaves become dwarfed, crinkled, and roll upward and inward. Veins become roughened on the under side of leaves and may produce swellings and spinelike outgrowths. Leaves that are mature at the time of infection typically do not show symptoms. The virus also dwarfs roots and leads to rootlets becoming twisted, distorted, and often killed. Other rootlets are produced to replace those killed leading to "hairy root" symptoms. On rapidly growing plants,

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phloem exudates may appear on petioles or larger veins of young leaves. These drops are clear at first but soon oxidize and turn dark (1). Roots of diseased plants may be discolored with the necrotic tissue marking the phloem areas of the vascular bundles. The severity of symptoms will vary depending on the susceptibility of the variety, virulence of the virus strain, and temperature (1). Plants of susceptible cultivars infected early in the season may die.

Disease ratings from a late planted artificially infested field (2004 Curly Top Nursery, Kimberly, ID) were compared with disease ratings and yield for the same varieties from a naturally infested field grown under commercial production conditions (2004 Variety Trial, Nampa, ID). Prior to these observations in 2004, data collected by Gallian and Stanger in 1992 at Malheur Experiment Station, Ontario, OR were the only data that provided for a similar comparison (3). Thus we conducted this study to confirm that the disease ratings taken under artificial conditions in the Curly Top Nursery correlate with disease ratings and yield under commercial conditions.

METHODS

A variety trial experiment with 29 varieties (Table 1) was conducted in a commercial sprinkler-irrigated sugarbeet field near Nampa, ID in an area where BCTV had been a problem in previous years. The field trial was planted on March 19, 2004 and relied on natural infection. The plots were planted to a density of 190,000 seeds/A, and thinned to 35,640 plants/A. Plots were four rows wide (22 in-row spacing) and 36 ft long. The experimental design was a randomized complete block with eight replications. The crop was managed by the grower according to standard cultural practices. The weather during the growing season was cooler than normal and symptoms began appearing in late May. Disease data were recorded on September 14 by three raters using a disease index of 0 to 9 (no symptoms to dead). The center two rows were harvested on October 20 using a small plot harvester. The sugar content of the beets was determined by the Amalgamated Sugar Co. laboratory, and the recoverable sugar was estimated.

The 2004 Curly Top Nursery with the same 29 varieties as the Variety Trial was conducted in a commercial field near Kimberly, ID. Plots 2 rows wide (22 in-row spacing) and 13 ft long were planted on June 7, 2004. The experimental design was a randomized complete block with three replications. The field had been fumigated with Telone (20 gal/A) on May 3 and then disked to seal the soil. The fertilization and weed control were consistent with commercial practices. The trial was initially irrigated with solid set sprinklers until June 26 and then switched to furrow irrigation. Viruliferous leaf hoppers (1.5 hoppers per plant) were applied on July 13. The field was sprayed with Lorsban (1.5 pt/A) to kill the leaf hoppers on August 4. Disease data were recorded on September 13 by three raters using the same disease index as in the variety trial.

The three disease ratings per plot were averaged prior to analysis. Data were analyzed using the general linear models procedure (Proc GLM-SAS), and Fisher's protected least significant difference was used for mean comparisons.

RESULTS

Yields were above average and disease pressure was uniform and moderately severe in the Variety Trial. The commercial hybrids response to *Beet curly top virus* ranged from acceptable (slight leaf curl to most leaves with moderate curling) to severely affected (larger leaves becoming prostrate). Analysis of variance indicated there were significant differences among hybrids for diseases index, root yield, sugar content, and estimated recoverable sugar (Table 1). Disease ratings from the Variety Trial were positively correlated ($r = 0.91$, $P < 0.0001$) with those from the 2004 Curly Top Nursery in Kimberly, ID (Fig. 1). The regression line (Fig. 2) for estimated recoverable sugar versus disease rating indicated that yield was related to disease severity ($r^2 = 0.54$, $P < 0.0001$). For each integral increase in disease rating there was a decrease in yield of 957.53 pounds of estimated recoverable sugar.

DISCUSSION

These results indicate that the Curly Top Nursery can be used effectively to identify varieties with resistance that will directly lead to improved yield in a commercially managed field. Disease ratings in the Curly Top Nursery and Variety Trial confirmed results gathered by Gallian and Stanger at Malheur Experiment Station in 1992 (3). Under severe disease pressure they found a negative relationship ($r^2 = 0.79$, $P < 0.0001$) between yield (tons/A) and disease index, which confirms the findings in this report. Regression analysis indicated that disease rating explained a significant portion of the variation in estimated recoverable sugar under moderate disease pressure. Thus, the Curly Top Nursery can be used to select resistant varieties which are the main line of defense against this disease.

LITERATURE CITED

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Table 1. Yield and beet curly top disease ratings from the 2004 Variety Trial at Nampa, ID.

Commercial hybrids	Disease index*	Root yield (T/A)	Sugar content (%)	Estimated recoverable sugar (lb/A)
Beta 8600	3.88	49.07	16.24	14039
HM Alliance	3.42	47.25	16.20	13585
HM Oasis	3.00	47.91	16.03	13541
Beta 4490 R	4.24	45.44	16.69	13403
HM 2986 RZ	3.33	47.25	16.01	13369
Cascade	3.08	46.56	16.20	13359
Acclaim R	3.67	47.94	15.85	13260
HM PM21	2.83	44.90	16.46	13063
HM 2980 RZ	3.88	46.74	15.84	13026
Beta 4199 R	4.09	44.34	16.42	12876
Puma	3.21	44.99	16.07	12785
Crystal 217 R	5.16	46.07	15.77	12676
Meridian R	3.79	46.05	15.67	12662
HM Owyhee	2.95	44.11	16.20	12636
HM 2984 RZ	3.46	44.98	15.82	12597
ACH Mustang	3.92	44.99	15.92	12516
Beta 8220 B	4.08	44.48	16.03	12499
Phoenix R	4.42	45.34	15.58	12464
HM 1642	4.58	42.14	16.51	12363
Crystal 333 R	5.29	43.34	15.97	12097
HM 2989 RZ	4.33	42.32	16.23	12082
Eagle R	4.50	43.77	15.55	12007
HM 2988 RZ	4.50	40.76	16.28	11789
Raptor RZ	5.00	41.85	15.77	11640
Beta 4035 R	4.21	42.80	15.28	11479
Beta 4773 R	5.14	40.48	15.91	11308
HH 142 R	4.58	39.55	15.87	10992
Crystal 9906 R	5.00	39.56	15.56	10921
Beta 4614 R	5.92	36.63	14.17	9134
$P > F$**	<0.0001	<0.0001	<0.0001	<0.0001
LSD ($P \leq 0.05$)	0.27	2.68	0.39	742

* Disease index scores were analyzed after the means score for each plot (three ratings per plot) were determined. The disease index scale ranged from 0 = no symptoms to 9 = dead plant.

** $P > F$ was the probability associated with the F value. LSD = Fisher's protected least significant difference value.

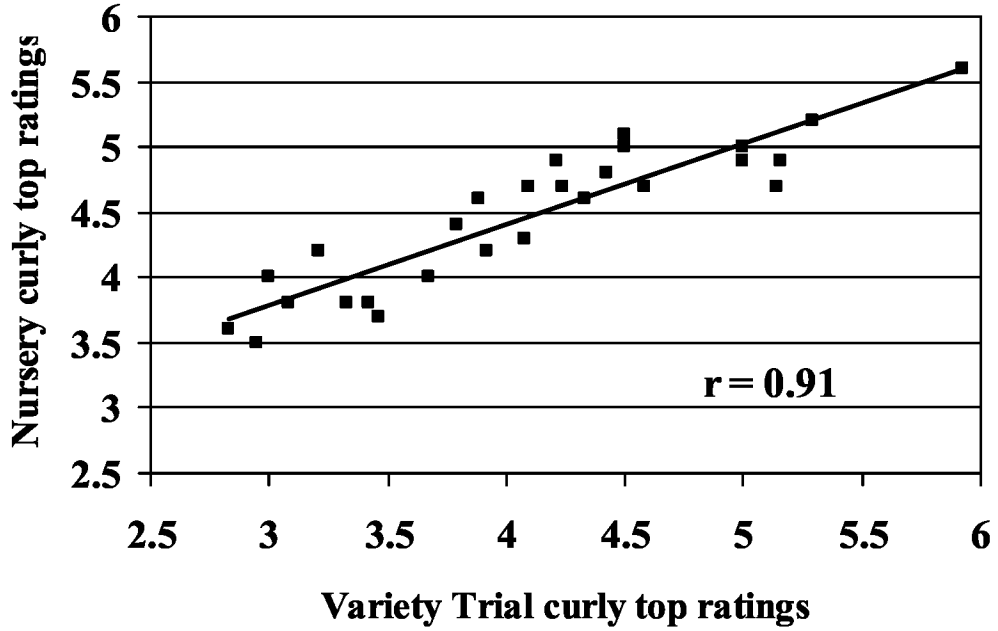

Figure 1. The relationship between disease ratings for 2004 Curly Top Nursery at Kimberly, ID and 2004 Variety Trial at Nampa, ID using a disease index of 0 to 9 (no symptoms to dead) and the same cultivars.

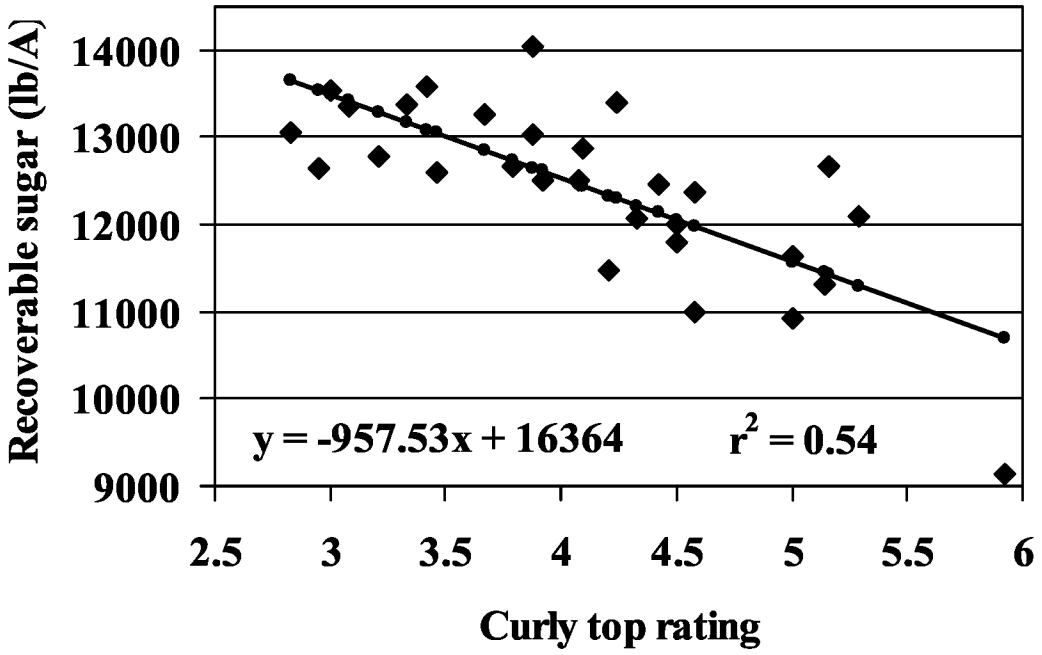

Figure 2. Relationship between disease rating and recoverable sugar in the 2004 Variety Trial at Nampa, ID using a disease index of 0 to 9 (no symptoms to dead).