Cultivar Blends for Buffering Against Curly Top and Leafspot Diseases of Sugarbeet[1]

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The argument is often advanced that populations composed of genetically diverse types should have increased stability of performance over fluctuating environments. Conceptually, an array of genotypes in a heterogeneous population possesses the ability to utilize a variety of environmental niches and should respond in a relatively uniform way to exigencies of the environment.

Multiline cultivars of some small-grain crops have been developed to control diseases and increase yields. The concept was also applied in 1971 when the outbreak of *Helminthosporium maydis* on T-cytoplasmic male-sterile lines in corn and the limited number of corn hybrids with resistant normal cytoplasm encouraged the use of seed blends.

Multilines are blends of different genotypes each of which, in the simplest case, contains a different gene of resistance. Browning and Frey (2)[3] reviewed the use of multilines in small-grain disease control. They support the development of multilines. Researchers at CIMMYT are also using the multiline approach in developing new wheat cultivars (6).

There is considerable evidence that reproductive ability of several crops is enhanced by variations in genotypic association. For example, enhancing effects were observed for particular sets of genotypes in wheat (1, 7), barley (1), potatoes (4), and soybeans (3, 5, 9, 11).

Scheifele (10) and Josephsen et al. (8), working with blends of T-cytoplasm and N-cytoplasm hybrid corn, found some buffering effect of N-cytoplasm against the southern corn leaf blight disease. The buffering percentage, as measured by yield, depended on the proportion of T-cytoplasm plants in the blends. Fehr and Rodriguez (5), working with soybeans, found all their blends produced highest yields when the highest yielding cultivar made up at least 70 percent of the blend.

The yield and disease performance of a blend can be evaluated by its compensating response. Compensatory response is the deviation of a blend's actual disease reaction from the mean weighted disease

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[3]Numbers in parentheses refer to literature cited.

reaction (expected disease reaction) of the component cultivars in pure stand. Four types of compensatory responses in a blend have been identified: neutral, complementary, overcompensatory, and undercompensatory. Neutral and complementary responses result in a blend performance that is equal to the expected performance. An overcompensatory response represents a greater performance and an undercompensating response a lower performance than expected.

Sugarbeet cultivars most generally planted on the High Plains of eastern New Mexico are hybrids from a curly top-resistant parent and a leafspot-resistant parent. These hybrids are intermediate in resistance to both diseases. Severe losses may occur as a result of epidemics of leafspot and curly top, either separately or concurrently, in the same year.

The objective of this study was to determine whether seed blends could be used as a buffer against both curly top and leafspot diseases of sugarbeets.

Materials and Methods

Replicated field tests were conducted each year from 1972 to 1974 at the Plains Branch Station, Clovis, New Mexico. The description of the seven entries included in all years were:

Curly top-resistant hybrid (CTR)
Cercospora leafspot-resistant hybrid (LSR)
Holly Hybrid 10 (CTR x LSR) (check)
US H9B (CTR- and virus yellows-resistant) (check)
Blends 3-CTR to 1-LSR
1-CTR to 1-LSR
1-CTR to 3-LSR

The blends were based on the percentage of viable seeds.

The severity of sugarbeet diseases is sometimes associated with the physiological development of the plant. Therefore, it seemed desirable to plant these blends at three different times (early, medium, and late). Table 1 gives the three dates of planting, the amount of fertilizer applied, number of irrigations, and the harvest dates for the three tests.

Plots were 20 feet long with two rows on a 40-inch bed. The rows were approximately 12 inches apart. The complete plot (40 linear

Table 1. — Planting dates, fertilizer applied, number of irrigations, and harvest dates for sugarbeet tests, 1972 to 1974, Plains Branch Station, Clovis, New Mexico.

Year	Date of Planting			Fertilizer	No. of	Date of
	1st	2nd	3rd	N-P-K	Irrigations	Harvest
1972	2/25	3/23	4/19	200-0-0	9	12/20
1973	3/7	3/28	4/18	200-0-0	10	10/31
1974	3/15	4/16	5/1	200-0-0	12	11/26

feet) was harvested for yield, and a 12-beet sample was saved for sucrose determination. Each test contained five replications.

The incidence of culy top was reported as a percentage of infected plants from an entire plot. Curly top percentages were transformed (arc-sine) for statistical analysis.

Leafspot ratings were made on a scale from 1 to 9. Ratings of 1, 2, or 3 were considered resistant; 4, 5, and 6 intermediate; and 7, 8, and 9 susceptible.

Results and Discussion

The disease reactions and yield components for the sugarbeet cultivars tested are shown in Figures 1 through 5. Every year, sucrose yields differed significantly between planting dates. Early-planted beets produced more sucrose. Only one significant interaction was detected between cultivars and planting dates during the three years of testing. Therefore, the cultivar means were averaged over the three planting dates and the five replications and these means were used to construct the various graphs.

Figure 1 shows the curly top percentages of the cultivars for each year and the average across three years. Curly top incidence was light in 1973 and only moderate the other two years. The blend cultivars did not deviate greatly from the expected, but the observed curly top percentages tended to be below the expected. The 1:1 ratio and the 1-CTR:3-LSR ratio were 14 and 10 percent, respectively, below the three-year average of 45 observations. The response of blends to curly top infection showed only a slight buffering effect.

The compensatory response of blends to Cercospora leafspot disease is shown in figure 2. These responses were considered to be slightly overcompensatory as most of the observed disease readings for the blends were below the expected. The buffering effect for the 3-CTR:1-LSR averaged 13 percent.

The yields in tons per acre are given in figure 3, sucrose percentage in figure 4, and pounds of sucrose per acre in figure 5. These responses were very erratic between years but tended towards neutral or undercompensation. The three-year average sugar yield of the LSR cultivar in pure stand outproduced all its component blends, the CTR cultivar, and the local check variety HH10. However, the check hybrid US H9B produced the highest three-year average of sugar per acre (figure 5). Although US H9B gave an excellent yield in this area, it tended to be low in quality, measured by sucrose percentage (figures 3 and 4).

The three-year average yield of blends in this study was lower than the highest yielding LSR cultivar and showed only a slight buffer-

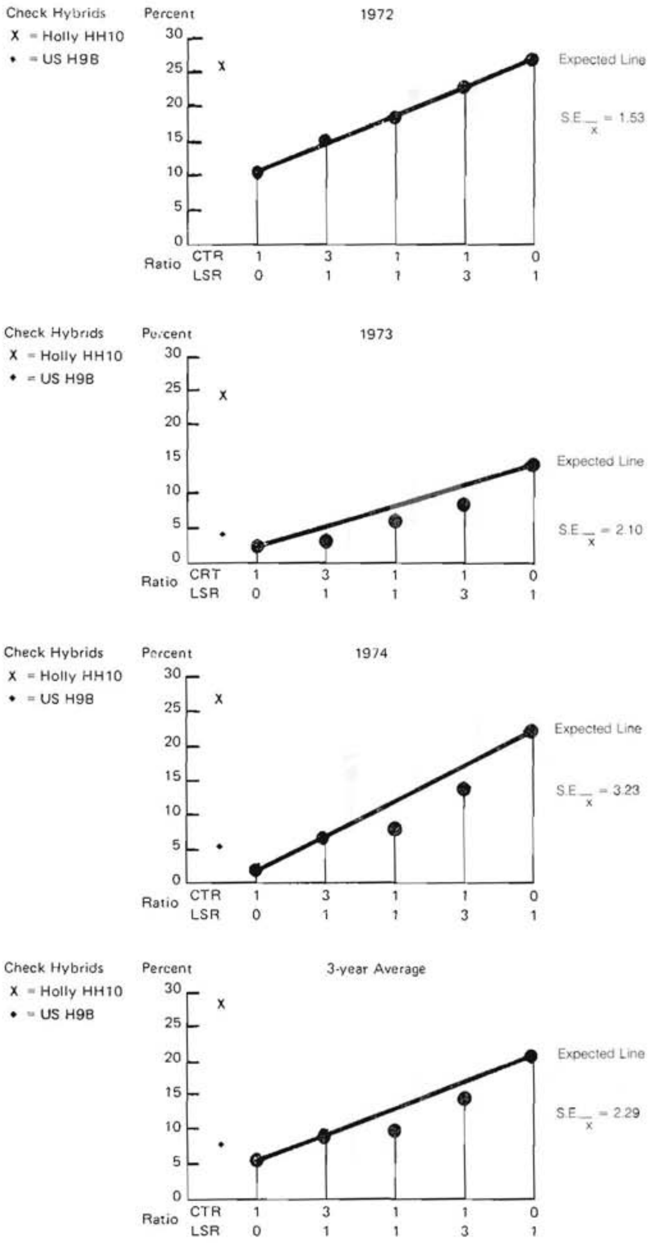

Figure 1. — Mean curly top percentages for sugarbeet blends, 1972, 1973, 1974 and combined years. Plains Branch Station. (Expected line is the linear relationship between the two cultivars in pure stands.)

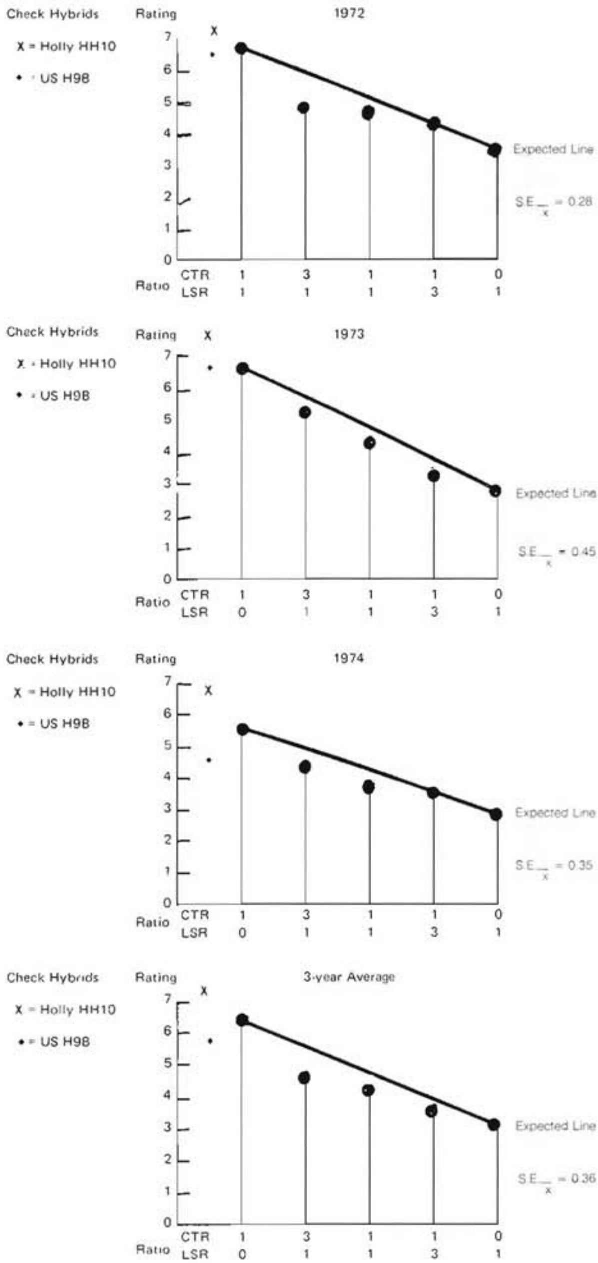

Figure 2. — Mean leaf spot disease rating of seed blends, 1972, 1973, 1974 and combined years. Plains Branch Station. (Expected line is the linear relationship between the two cultivar in pure stands.)

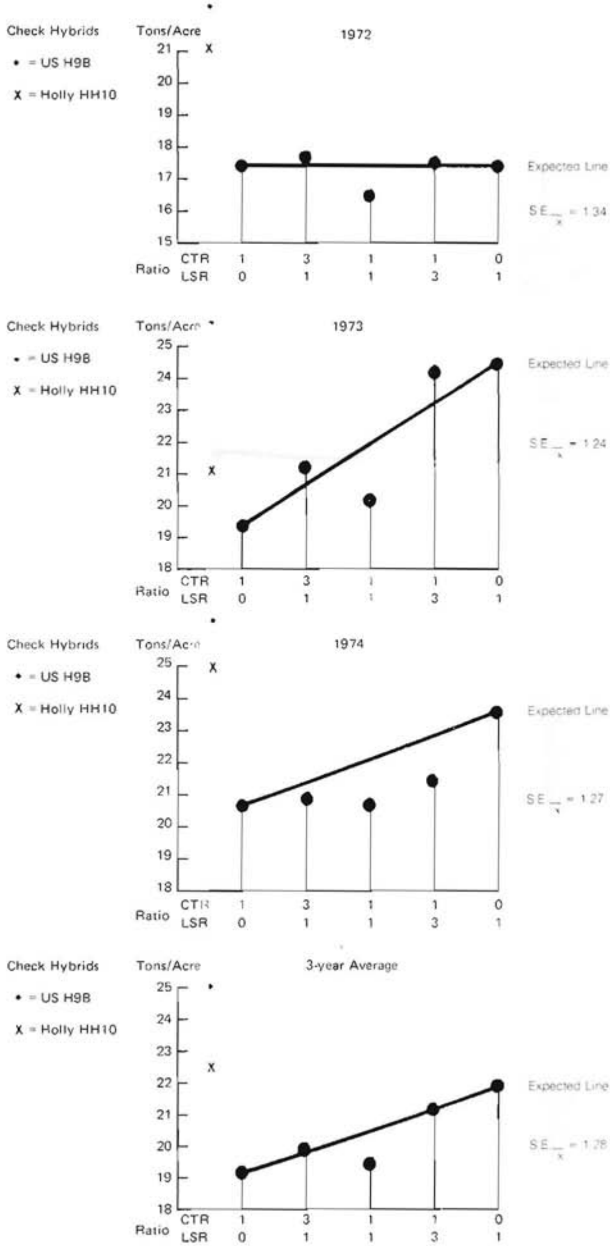

Figure 3. Mean tonnage yields for sugarbeet blends, 1972, 1973, 1974 and combined years. Plains Branch Station. (Expected line is the linear relationship between the two cultivar in pure stands.)

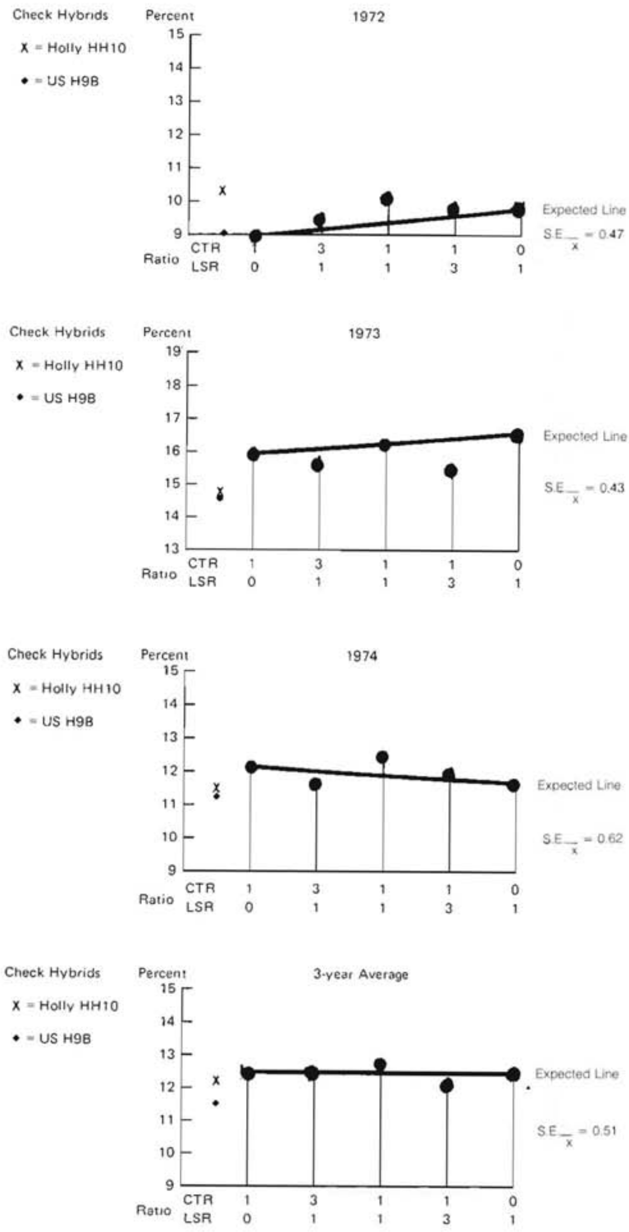

Figure 4. Mean sucrose percentages for sugarbeet blends, 1972, 1973, 1974 and combined years. Plains Branch Station. (Expected line is the linear relationship between the two cultivar in pure stands.)

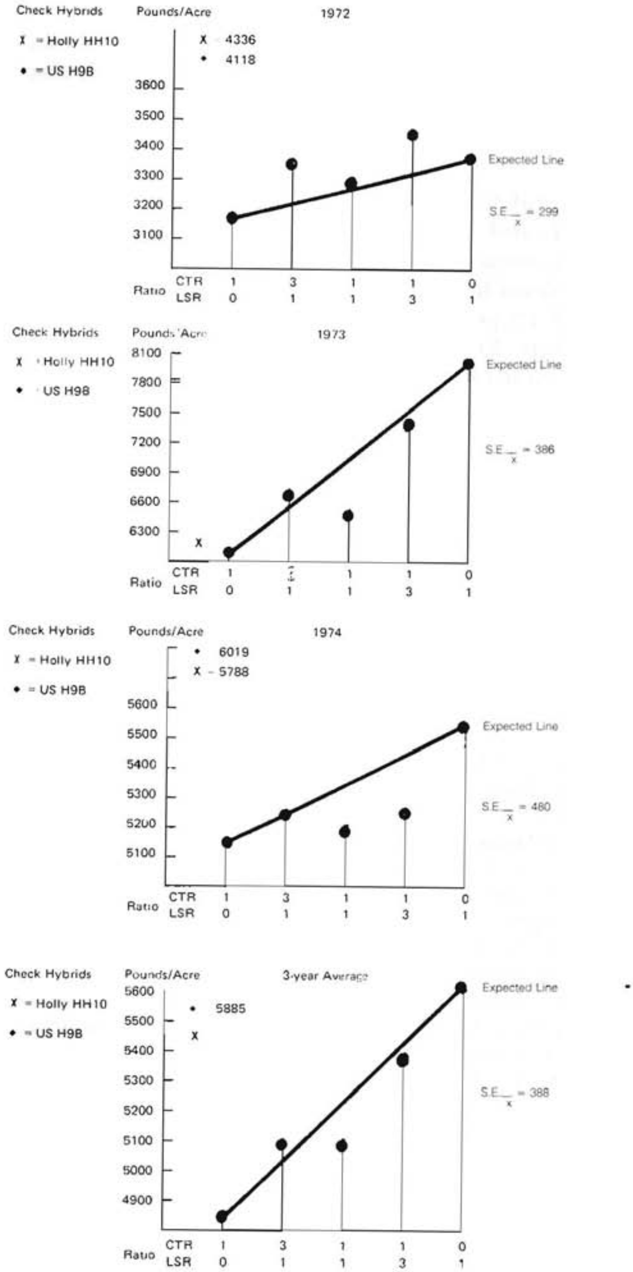

Figure 5. Yield of sucrose (pounds per acre) for sugarbeet blends, 1972, 1973, 1974 and combined years. Plains Branch Station. (Expected line is the linear relationship between the two cultivar in pure stands.)

ing against curly top and leafspot diseases. The three blends represented only a very small sample of blends and cultivars that could be used in blends. Greater success may be achieved if both disease-resistant cultivars are high yielders.

Summary

Curly top- and leafspot-resistant cultivar seed were blended in ratios of 1:3, 1:1, and 3:1. The blends and the two resistant cultivars, along with two commercial check hybrids, were field-tested for three years. The 1:1 blend had 14 percent less curly top and the 3:1 (CTR: LSR) blend had 13 percent less leafspot than was expected from a linear relationship. Yield responses were erratic between years but tended towards neutral or undercompensation.

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