W.M. WINTERMANTEL, J. SEARS, and M. PARRISH. USDA-ARS, Salinas, CA 93905. **Synergism and Host Effects in Virus Yellows of Sugarbeet.**

Virus yellows of sugarbeet is caused by one or more aphid-transmitted viruses that produce severe interveinal yellowing on sugarbeet leaves, and stunting of beet growth and development. The virus yellows disease complex is composed of members of two main genera of plant viruses, a polerovirus (formerly called a luteovirus) and a closterovirus. Often, *Beet mosaic potyvirus* is present, as well, although generally this virus does not contribute to significant disease alone. In most beet growing regions, *Beet western yellows virus* , and the closely related polerovirus, *Beet chlorosis virus* are primarily responsible for the disease. In California, however, *beet yellows closterovirus* (BYV) also contributes significantly to virus yellows. The viruses responsible for yellows in Europe differ from those in the U.S. Although BYV is present in Europe, most virus yellows outbreaks are the result of another polerovirus, Beet Mild Yellowing Virus (BMYV). BChV is also present in Europe, and appears to be very similar to American isolates. Europe also has a polerovirus called BWYV that infects oilseed rape, but unlike the American BWYV, the European BWYV does not infect sugarbeet. American BWYV, in addition to infecting sugarbeet, also infects oilseed rape, as well as broccoli, Shepherd's purse and lettuce.

In many beet growing regions throughout the world, virus yellows of sugar beet is considered to be one of the most significant threats to yield and sugar production. If infection occurs early in the season, losses can be as high as 50 percent. Direct annual losses to virus yellows in California average in excess of $36 million, without considering indirect effects such as the displacement of production areas, increased freight costs, and potential loss of processing facilities due to disease-related yield and revenue reductions. In the mid 1970's sugar had to be rationed in the UK due to losses caused by virus yellows. The same or similar poleroviruses infect other crops including lettuce and oilseed rape (canola), which are often grown concurrently in the same agricultural systems, adding to the agricultural losses caused by these viruses. Although beet-free periods are useful in managing virus yellows, the increased range and population of *Aphis fabae*, the black bean aphid (an efficient vector of BYV, but not poleroviruses), and erosion of the beet-free periods, has made virus yellows more difficult to control in recent years. Once plants begin showing symptoms, losses increase approximately 2 percent each week through the remainder of the growing season. Traditionally, breeding for resistance to virus yellows has involved breeding for control of the yellowing symptom, caused by the poleroviruses and/or BYV. Currently, beet breeding lines are available which exhibit tolerance to BYV, BWYV, and BChV. Virus can still accumulate in beet leaves and symptoms appear, but disease severity is reduced. By gaining a better understanding of the virus interactions that contribute to virus yellows of sugarbeet, we should be able to develop engineered resistance to target key components of the disease complex.

In this study, sugarbeet varieties exhibiting differential levels of tolerance to the yellows complex were inoculated with every combination of one, two or all three viruses. Plants were grown for 8 weeks in the greenhouse. Root and total weights were determined and compared to mock-inoculated beets. Specific combinations of viruses severely affected growth of beet plants, resulting in stunted plants compared with both healthy beets and beets infected with only one virus. Stunting effects were most dramatic in susceptible beet varieties, but were also observed in tolerant varieties. Mild increases in stunting severity were found in mixed infections of BYV and BWYV, compared with single infections. Mixed infections of BYV with BtMV, however, caused severe stunting in sugarbeet, compared to single infections of either virus or the combination of BYV with BWYV. Differences in stunting severity were significant between single and double infected plants, particularly in susceptible varieties. Differences were less in tolerant varieties of sugarbeet.

Virus concentration was also affected by mixed infections. Levels of BYV and BtMV were most affected by the presence of an additional virus, as compared to virus levels in single infections. BYV levels doubled in the presence of BWYV, but were suppressed when beets were co-infected with BtMV, compared with single infections. In addition, BtMV levels increased substantially in the presence of BWYV. Other virus combinations did not demonstrate specific effects on co-infecting viruses.