Analyses of Virus Disease Management Programs

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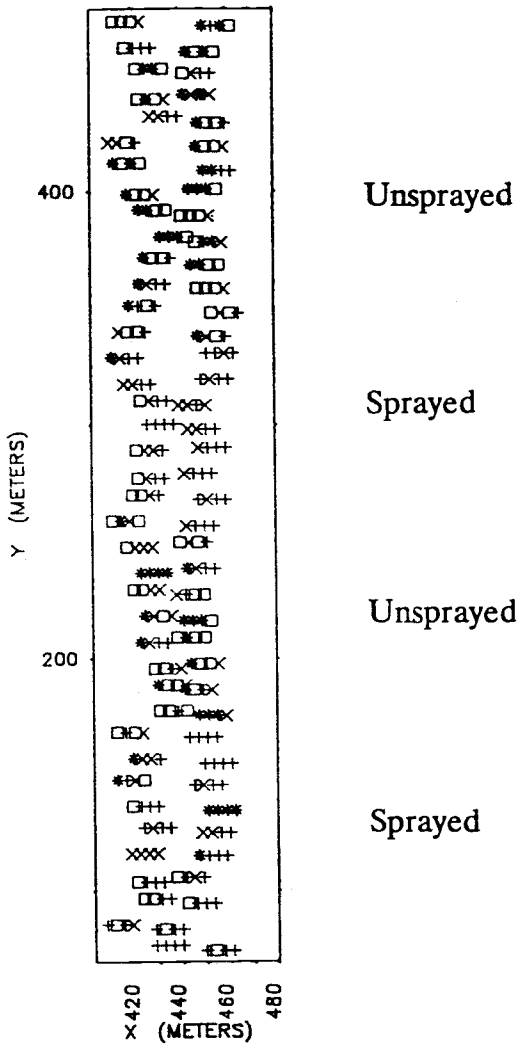
Complex management programs to reduce losses from plant virus diseases are necessary for those diseases, such as lettuce infectious yellows, that have no obvious single approach to mitigating losses. It may be possible by a carefully designed program to reduce or delay infection but such programs must be carefully designed, and managed. Such programs might require efforts to be directed toward several different aspects of the epidemiology of the disease such as weed control, timing of the crop, vector control, spatial arrangement of crops and crop plant spacing. These actions to be effective may require action at times of the year when the crop in question is not present and their effectiveness shows up only when at least several actions are taken in an integrated, coordinated way. Historically only a few such programs have worked because they are difficult to conduct and demonstrate effectiveness. By using geographical information systems (GIS), geostatistics, and associated software, we can develop a method of analyzing such management programs to demonstrate not only their effectiveness but also make improvements.

Geostatistics can be used to analyze virus dispersion characteristics in a single field, in a local area or in a region. The analyses may be mapped using GIS to show the crop infection level as influenced by local or distant epidemic components. This information can be used to demonstrate the effectiveness of a management plan and stimulate growers to use it.

The two figures of this paper are designed to illustrate the type of visual material that could be generated from data analyzed by or interpreted by GIS. Data collected from a single field can be displayed using the coordinates from the observation point (Fig. 1). The goal is to place those observations in the context of a larger perspective (Fig. 2). By studying the regional effects -- using various sized-regions -- we hope to understand the most appropriate size region to which management efforts should be directed. We also plan to look for interactions of regional factors that affect the pattern of disease observed in a single field (Fig. 2). Such information properly analyzed and visually illustrated could affect decisions at the field level.

Data collected from a lettuce field can be displayed graphically as part of a Geographical Information System (GIS) analysis. This map shows the location of subplots containing up to 32 lettuce plants with symptoms of lettuce infectious yellows. The 320 subplots are assigned to quartiles depending on the number of plants in the subplot showing symptoms. Twenty-five percent of the subplots (first quartile) have between 9 and 20 plants with symptoms ("+" symbol). The clustering of the best subplots ("+") is possibly related to the stylet oil treatment.

The plot is to scale. The X and Y coordinates represent the last 3 digits of the Universal Transverse Mercator (UTM) coordinates. UTM's for each location were established using a topographical map, a digitizer and ARCINFO (a GIS software). By using UTM's to locate the subplots, these subplots can be tied with other geographical information about land surrounding the plot. The plot is generated by Geo-EAS software.



1st Quartile:	$9.000 \leq + \leq 20.000$
2nd Quartile:	$20.000 < \times \leq 22.000$
3rd Quartile:	$22.000 < \square \leq 25.000$
4th Quartile:	$25.000 < * \leq 32.000$

Figure 1. Location of dataplots and example of a GIS map of plants showing symptoms of lettuce infectious yellows virus (LIYV) on November 15, 1989.

Figure 2. View of infection potential from a regional perspective. This stylized illustration shows the type of regional effects that might be discovered. For example, whiteflies might move from the vector source field in the prevailing wind direction into fields 1, 2, 3, and 4 but no disease occurs in these fields because the vector did not yet encounter the virus. However, as the vectors move from these fields through the weedy area, they pick up the virus and carry it into fields 5 - 9. The proximity of vectors and plants harboring the virus may therefore determine the severity of an epidemic on a regional basis. Removal of the weeds may significantly reduce the risk of crop loss from the virus disease.