# Spatial Analysis of *Aspergillus flavus* S and L Strains

*T. V. Orum, D. M. Bigelow, P. J. Cotty, and M. R. Nelson.*
*Department of Plant Pathology, University of Arizona, Tucson, AZ and USDA/ARS/SRRC, New Orleans, LA.*

### *Abstract*

*The distribution of S and L strains of Aspergillus flavus is more stable than previously realized. Analysis with GIS/geostatistics shows that patches of similar S strain incidence persist over years. This information will be exceptionally useful to programs involved with or planning large-scale treatments to reduce aflatoxin contamination because it can be used to spatially focus treatments.*

## Introduction

The *Aspergillus flavus* community at the soil surface is genetically diverse. The community can be sub-divided into two strains (S and L) based on the morphology and growth rate of the sclerotia (Cotty 1989). Because S strains consistently produce large amounts of aflatoxin (>98 %), strain composition at the soil surface will influence the level of aflatoxin in the crop. We have found areas in Yuma County that consistently average above 80 % S strain incidence. A reduction in the S strain incidence in those areas has the potential to reduce aflatoxin contamination in cotton. Some L strain isolates produce no aflatoxin at all (Cotty et al. 1994). These isolates are of particular interest in aflatoxin management. An experimental use permit for commercial field trials of atoxigenic strains to modify the *A. flavus* strain composition was granted to P. J. Cotty in 1996 for treatments in 1996, 1997, and 1998 (Cotty et al. 1997). Understanding spatial patterns of strain composition will be useful in possible future treatments with atoxigenic strains.

## Sampling results

The pattern and scale of the strain composition of *A. flavus* is determined by collecting soil samples from the top .5 cm of soil and plating in the laboratory. Most biological variables are spatially autocorrelated at some scale. Autocorrelation means that a variable (such as the percentage of isolates that are S strain) is correlated with itself (auto) as opposed to another variable (cross). We use the term "patch" to describe an area in which a variable has similar values – i. e. an area in which there is spatial autocorrelation. The range of distances over which there is spatial autocorrelation is an estimate of the patch size. Since 1994, repeated sampling of soil in Yuma County, AZ cotton growing areas has shown that S strain incidence is patchy and that patches persist overtime (Orum et al. 1997). There is spatial autocorrelation over two ranges: 2.5 km and 25 km. Sampling of fields adjacent to the originally sampled fields in July 1996, October 1996 and March 1997 have demonstrated that patches of low S strain incidence extend beyond field boundaries and do not correspond in an obvious way with the crop in the field or with field crop sequence. Many locations have shown a very stable strain composition over time. For example, samples from the corner of one field in the Texas Hill area of eastern Yuma County, has had an S strain incidence between 80 and 100 % for eight consecutive sampling dates (Fig. 1). In another field in the area, strain S incidence has been under 35 % seven of eight times (Fig. 1).

## Mapping strain incidence

Because S strain incidence is relatively stable over time, strain composition maps of regions will be significant. In July 1997, we began sampling from other locations broadly distributed in the Texas Hill and North Gila areas of Yuma County so that we can better map S strain incidence. The point data can be interpolated using geostatistics to produce either grid cell maps or contour maps. Variogram analysis shows a strong spatial autocorrelation with a range of 2.5 to 3.5 kilometers. This supports the appropriateness of the geostatistical approach to the mapping and is a refinement on our previous estimate of important spatial structure between 1 and 5 km using the nested ANOVA's. Using July 1997 data, we have generated preliminary sub-regional maps of the Texas Hill area. Much of the area averages over 60 % S strain with a significant subset averaging over 80 % (Fig. 2). However, there are two patches that average below 60 % (Fig. 2).

Using geographic information systems (GIS) software, we overlaid S strain incidence contours onto USDA SCS soil maps. The patches of low S strain incidence are in different soil types and the highest S strain incidence areas include diverse soil types. Therefore, our analysis of soil characteristics needed to go beyond the USDA SCS soil classification scheme. In collaboration with T. L. Vinnie and Dr. D. F. Post of the Department of Soil, Water, and Environmental Science at the University of Arizona, forty six soil samples, taken from the same sites as samples for analysis of strain composition, have been analyzed. Preliminary results indicate a negative correlation between S strain composition and boron concentration and a positive correlation with sand content (Table 1). We are just beginning analyses of the soil data and are cautious about interpretations at this point.

## Discussion

Knowledge of the distribution of S strain composition and/or soil characteristics that support high populations of S strain can be very useful in focusing the application of control measures such as the atoxigenic biocompetitive L strain being applied experimentally on approximately 500 acres of Arizona cotton.

## References

Cotty, P. J. 1989. Virulence and cultural characteristics of two *Aspergillus flavus* strains pathogenic on cotton. Phytopathology 79:808-814.

Cotty, P. J., P. Bayman, D. S. Egel, and K. S. Elias. 1994. Agriculture, aflatoxins, and Aspergillus. Pages 1-27 in: The Genus Aspergillus: From Taxonomy and Genetics to Industrial Applications. K. A. Powell, A. Renwick, and J. F. Peberdy, eds. Plenum Press, New York.

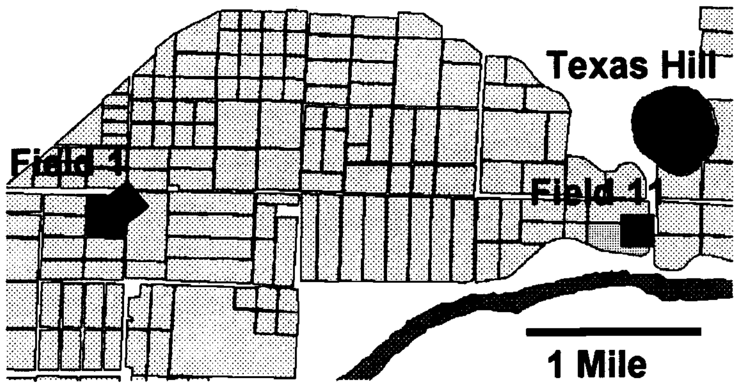
Cotty, P. J., D. R. Howell, C. Bock, and A. Tellez. 1997. Aflatoxin contamination of Bt cottonseed. Cotton, A College of Agriculture Report. University of Arizona. Series P-108: 435-438.

Orum, T. V., D. M. Bigelow, M. R. Nelson, and P. J. Cotty. 1997. Spatial and temporal patterns of *Aspergillus flavus* strain composition and propagule density in Yuma County, Arizona, soils. Plant Disease 81:911-916.

**Table 1. S strain incidence in relation to selected soil characteristics is shown in a similarity matrix using Pearson's correlation coefficient.**

| | Strain S (%) | Boron | pH | EC | Sand | Wet Hue (%) |
|---|---|---|---|---|---|---|
| Strain S (%) | 1.00 | | | | | |
| Boron | **- 0.57**[a] | 1.00 | | | | |
| pH | 0.06 | **- 0.33** | 1.00 | | | |
| EC | - 0.28 | **0.77** | **- 0.53** | 1.00 | | |
| Sand (%) | **0.34** | - 0.2 | - 0.1 | 0.03 | 1.00 | |
| Wet Hue | **- 0.44** | 0.26 | - 0.11 | 0.28 | - 0.16 | 1.00 |

[a]The correlations are based on soil collected at 46 locations in the North Gila Valley and Texas Hill areas. Bold indicates $p < 0.05$.



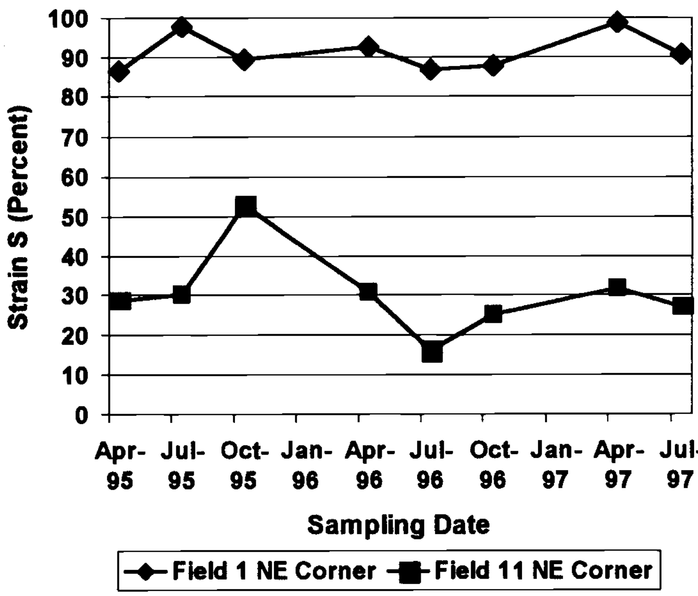




Figure 1. The incidence of *A. flavus* strain S was relatively stable between April 1995 and July 1997 at two sampling locations in the Texas Hill area. Field 11 is in a patch where S strain incidence is lower than the average for the Texas Hill area.

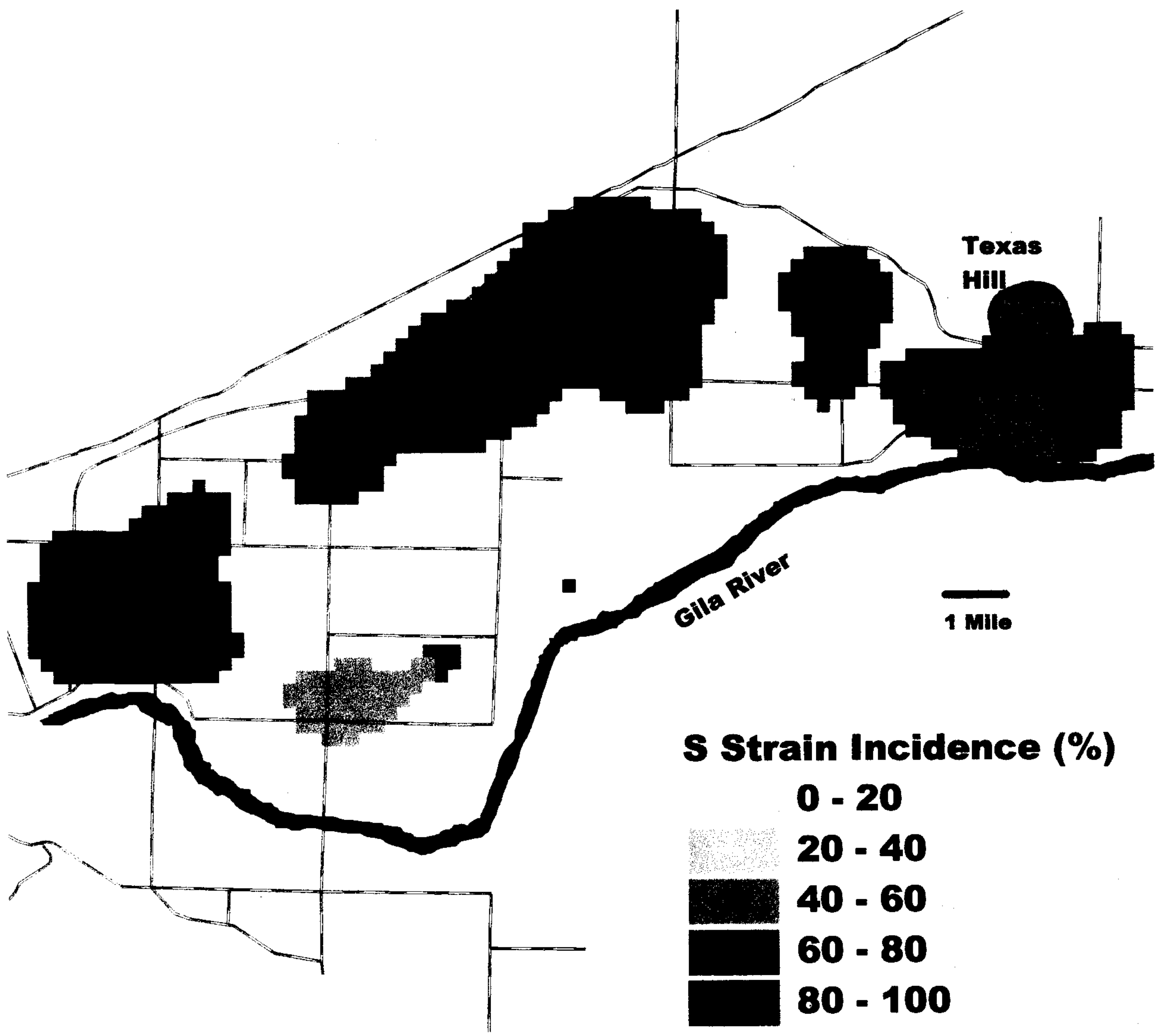



Figure 2. Grid map of A. flavus strain composition in the Texas Hill area, based on kriging. Grid cells are 120 m by 120m. Strain incidence averages over 80% in much of the area, but there are two patches where S strain incidence averages between 40 % to 60 %.