End of the Era of Uniform Herbicide Applications?

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Introduction

Environmental improvements and reduced costs may be derived by reducing pesticide use through precision application of chemicals only to areas with pest infestations instead of treating entire fields at uniform rates. Methods of spatial statistics (geostatistics) are developed to describe variation, develop maps, and improve sampling of weed populations.

Material and Methods

Commercial fields with processing tomatoes were used for the research. The fields were located in Yolo county, California. In 1998 and 1999 weed densities were recorded by field sampling on a grid using a hand held data logger with a Differential Global Positioning System. Grid spacing was 150 ft (= 30 rows) across rows and 170 ft along the row. Weed seedling densities were monitored during the tomato season. Weed densities were counted in $0.25 m^2$ quadrat at every grid point. Counts were recorded for individual weed species.

Geostatistical methods were used to quantify weed densities by using GS+ software. The geostatistical procedure is useful for obtaining weed infestation maps with reasonable sampling size. Semivariogram interpolation (kriging) was done for calculating weed densities between sampling points as a basis for selective spraying. The number of neighboring points used in kriging was chosen based on the results of the cross-validation. Contour maps were constructed showing the estimated barnyardgrass density. The percentage of the field with various densities of barnyardgrass was plotted against hypothetical threshold values to examine scenarios involving selective control. The locations of weed-free area in two consecutive years were compared to assess the accuracy of predicting weed infestation from previous years.

Results and Discussion

Barnyardgrass (*Echinochloa cruss-galli*) and black nightshade (*Solanum nigrum*) accounted for approximately 80 % of the total weed counts in both years 1998 and 1999. Original data did not follow a Gaussian distribution and were log-transformed. Semivariograms of transformed data were plotted. The least squares procedure was used to fit the model to sample variogram.

Within high density areas the plants were spatially related within 60 ft. At larger scale, the percentage of autocorrelation was about 85 %, indicating that, within the range of 450 ft, there was a 85 % variation in seedling density explained by the distance between points. The large scale variability might be due to field cultivations and harvesting procedures.

The area of field free of barnyardgrass plants reached 30 % in 1998 and 40 % in 1999. About 50 % of the field had less than 5 plants of barnyardgrass per square meter in both years. About 17 % of the field had no weeds in both subsequent years. If the simple selective application strategy with on-off nozzle function is implemented, a herbicide saving of up to 30 to 70 % could be achieved.

Conclusions

Weed species occur in a spatially aggregated pattern. More abundant species are less aggregated and their spatial pattern approach the random distribution. Less abundant weed species are highly aggregated.

The edges of the fields are more weedy than areas inside the field under conventional herbicide treatments.

Under the uniform herbicide application, weed clumps remain stable.

Geostatistical methods can be used to make weed maps.

Fields can be separated into areas with no weed infestation and areas with similar related weed densities.

The field weed maps provide data on the spatial pattern of weed infestation which, together with a weed treatment strategy, could be used to generate treatment maps.

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