EFFECT OF METHYL BROMDIE ALTERNATIVES ON TOMATO PRODUCTION: A LONG-TERM PERSPECTIVE

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Tomato is an important vegetable crop and Florida is a major supplier in the nation. However, the Florida tomato industry is facing challenges of increased production costs and decreased yields resulting from the methyl bromide (MBr) phase-out under the Montreal Protocol. Fresh tomatoes accounted for 50% of total MBr pre-plant usage in the United States before 2000 (Osteen, 2000). Since the MBr phase-out, Florida growers have gradually transitioned to other fumigants but these alternative fumigants lack the consistent, broad-spectrum effectiveness of MBr. In particular, in multi-year trials they provided inconsistent weed control (Locasco et al., 1997; Webster et al., 2001; and Glireath et al., 2005) and inconsistent efficacy under different pest pressures (Csinos et al., 1999; Dickson et al., 1999). This suggests that MBr alternatives are sensitive to external factors. For instance, weather conditions which have a marked influence on pest pressure also influence the performances of fumigant alternatives. Alternatives that have acceptable efficacy under favorable weather may fail in other years when weather is less favorable. In addition, effects of alternatives vary over time while pest populations build up or shift over time under continued use of a particular treatment. Therefore, to identify the most efficacious fumigant alternative it is necessary to examine effect dynamics of each alternative over time. In this study, we investigated the interactions of alternatives with external factors such as weather and cropping system and analyzed their efficacy over time. The long-term efficacy of fumigant alternatives was simulated with different weather variations (scenarios), and the optimal fumigant program in terms of economic return is identified.

In prior studies, fumigant comparisons were limited to one to two years (e.g., Gilreath and Santos, 2004; and Santos, 2009). To evaluate treatment effects over time, multi-year studies are needed. Scientists at the University of Florida Gulf Coast Research and Education Center (GCREC) recently completed a long term trial that ran from the fall of 2008 to the fall of 2011. Alternative fumigants were evaluated to examine their effects on nematodes, weeds, soil-borne plant pathogens and yield; and tomato-squash cropping system was also experimented to examine double crop effects. With the exception of MBr:Pic, the experiment studied fumigation options that are now widely used, including 1,3-D:Pic, DMDS: PiC and 1,3-D:Pic+metam-K. Therefore, we use the data from this experiment to explore the relationship between the efficacy of fumigant alternatives and weather conditions and cropping system and estimate the effect of each alternative from a long-term perspective.

Method

To evaluate the dynamic effects of each alternative on yield over the cropping seasons, we develop a regression model to separate treatment effects from block-specific effects, weather effects, the effect of cropping system, and random errors. Weather effects are captured by temperature and rainfall variables in the regression model, and the temperature and rainfall data are obtained from the Florida Automated Weather Network (FAWN). To test for the interactions of treatment effects with external factors, the cross terms of treatments with weather and cropping system will be included in the regression and be examined for the statistical significance. A joint significant test would suggest that alternatives are sensitive to external factors. The dynamics of treatment effects over time are of special interest in this analysis. To estimate the dynamics of the effects, the parameters of treatments are assumed to be a function of time variable. A quadratic time trend is specified to explicitly take into account the nonlinear pattern of effects over time. The regression analysis will disentangle the time effects of pest management systems from those of weather differences across years and other factors.

The estimated model is then used to establish a baseline forecast of yield in future years. The weather variables in the model will be based on forecasts from the National Oceanic and Atmosphere Administration (NOAA). In the baseline scenario, we forecast yields under different treatments over the projected period. Tomato market prices used in the analysis are simulated based on historical prices in southwest Florida to account for price variation and risk. The net return of each treatment in each year will be calculated, and the subsequent years' returns will be discounted accordingly to compute the total return of a specific treatment over the entire projected period, which will then be used to rank different treatments from a long-term perspective. Contrary to the baseline case that weather variables are assumed to be deterministic, weather is taken as random variables in the second scenario. We simulate weather variables from its forecasted distribution for thousand times and calculate the average value of total returns. The highest value means the best performance under weather variation.

Discussion

We expect that the effects of treatments would vary over time and interact with external factors, in particular, weather. We will compare the results found from short-term and long-term analysis. The integrated evaluation will identify the economically optimal alternative(s) for long term success. The results from this analysis will help growers make optimal, forward-looking adoption decisions instead of the decisions based on a single-year or short-term analysis.