Effect of Pest Management Strategies on Economics of Small Scale Tomato Production in Mississippi©

Ronald C. Stephenson and Christine E.H. Coker
Department of Plant and Soil Sciences, Mississippi State University, Coastal Research and Extension Center, Biloxi, Mississippi 39532, USA
Email: cec117@ra.msstate.edu

Evaluation and improvement of management techniques is important to increase the viability of small scale vegetable production. Three management strategies, including calendar spray schedule, integrated pest management (IPM), and organic pest control, were evaluated in terms of their effect on yield and economic return for 'Celebrity' and 'Bush Early Girl' tomatoes in Mississippi. In Spring 2014, significantly greater yields were obtained from the IPM management system for both tomato cultivars studied. Significantly greater economic return was obtained from 'Bush Early Girl' IPM than for other 'Bush Early Girl' treatments. Total return from the 'Celebrity' IPM treatment was greater than that for the 'Celebrity' calendar treatment but not the 'Celebrity' organic treatment. When considered across both cultivars, the IPM management treatment resulted in significantly greater yields and total return than other treatments.

INTRODUCTION

The production of vegetables and melon in Mississippi (MS) accounted for an economic impact of $145.1 million in 2007 (USDA, 2007). In addition to this, vegetable production generated a total of $60.5 million in labor income (Posadas, 2011). Tomatoes grown in the open field accounted for 431 acres of production on 426 farms. Greenhouse production of tomatoes accounts for a further 31 farms, with approximately 4.6 acres under glass (USDA, 2007). Vegetables may be chosen as alternative crops for small scale production due to the potential for high economic return on small acreage. Small farms account for 81% of local food sales (Low and Vogel, 2011).

Insect pests have a significant impact on both crop yield and quality. However, there is limited information on the degree of damage resulting from insect pressure in small scale vegetable production. Between 20 and 30% of yield is lost annually in crops with extensive pest protection (Lucas, 2011). These losses may be even greater in crops where restricted use pesticides and resistant cultivars are unavailable. Many small scale vegetable producers lack certification for restricted pesticide use and may use cultivars with limited genetic resistance (e.g., heirloom cultivars) due to consumer demand. Improved crop protection strategies to limit damage may significantly increase production efficiency and food security (Lucas, 2011).

Concerns about health and environmental impact of the use of synthetic pesticides have led to significant changes in production practices. Integrated pest management (IPM) involves the judicious use of pesticides in response to field sampling of pest populations. Integrated pest management programs have been widely successful in reducing pesticide use while increasing profitability of crop production (Allen and Rajotte, 1990). Further, public concern about the health and environmental effects of pesticides is increasing. Organic production of vegetables is an increasingly important segment of the small scale vegetable production sector. In 2007, organic crops were harvested on 36 farms over a total of 482 acres in Mississippi (USDA, 2007). The efficacy of control for conventional pesticides is often greater than organic controls. When management practices were investigated, the type of pesticide used was the most important factor affecting insect populations (Hummela et al., 2002).

The objective of this study is to evaluate the effect of insect and disease pest management strategies on the economics of small scale vegetable production. The strategies to be considered in this study are management based on a calendar spray

schedule, integrated pest management (IPM) using conventional pesticides, and management using organic controls.

MATERIALS AND METHODS

Three management strategies were evaluated on two cultivars of tomato commonly available to growers in South Mississippi. In the first treatment, conventional insecticides were applied every 14 days after transplant regardless of observed insect pest populations. In the second treatment, conventional pesticides were applied when sampled insect populations were greater than established economic thresholds. The third treatment utilizes economic thresholds; however, pesticides used in this treatment were limited to those allowed in organic production. Tomato cultivars for this study include *Solanum lycopersicum* 'Celebrity' and 'Bush Early Girl' (Harris Seeds, Rochester, New York). These cultivars were transplanted into field plots 15 Apr. 2014 in accordance with recommendations provided by the Mississippi State University Extension Service. Plants were obtained as seed and grown under greenhouse conditions at the South Mississippi Brach Experiment Station prior to transplantation to field plots.

Plots were established in four locations in southern MS, including Kiln, MS, the South Mississippi Branch Experiment Station in Poplarville, MS, the Beaumont Horticultural Unit in Beaumont, MS, and the Stone County USDA Research Station located near Wiggins, MS. Six plots were established at each study location consisting of each of three treatments on each of the two cultivars on which these management practices were evaluated arranged in a randomized complete block design.

Plots for this study consisted of two 1.8×1.8×0.2 m (6 ft×6ft×8 in.) raised beds. Beds were constructed from four 5×20 cm (2×8 in.) boards. The growing media in each box consists of composted pine bark screened to 1 cm (⅜ in.) (Eaks Nursery Materials, Seminary, MS). Prior to planting, media from raised beds was sampled and submitted for testing at the Mississippi State University Soil Testing Laboratory. Recommendations for fertilization and lime application for tomatoes were followed. Watering of plots was conducted by drip irrigation system. Watering between study sites varied according to the needs of plants at that location. Sampling of plots was conducted weekly and consisted of whole plant visual examinations of four plants per plot.

Pesticides applied in this study were limited to those commercially available without a Private or Commercial Pesticide Applicator's license. In the calendar spray treatment, applications of Carbaryl (Sevin®, Bayer Environmental Science, Research Triangle Park, North Carolina) in a liquid formulation were conducted every 2 weeks after planting. This insecticide is chosen due to its broad availability, common use, and activity against a wide range of insect pests.

For the conventional, integrated pest management treatment, pesticide applications were conducted as dictated by pest populations. The pesticides used for this treatment were selected according to recommendations issued by the Mississippi State University Extension Service for control of the pest insect. Similar recommendations were followed for organic treatment plots. Insect thresholds from the Mississippi State University Extension Service were used when available. All plots for this study were sprayed prophylactically for common fungal diseases using a broad spectrum fungicide. Fungicide applications included Myclobutanil (Spectracide Immunox® Multi-Purpose Fungicide Spray Concentrate for Gardens, Spectrum Group, St. Louis, Missouri) and Chlorothalonil (Ferti-lome Broad Spectrum Landscape and Garden Fungicide Voluntary Purchasing Group, Bonham, Texas). All pesticides were used in accordance with label directions.

In order to evaluate management strategies in terms of economic benefit, the cost of inputs was recorded. The cost of all pesticide treatments was calculated by measuring the volume of pesticides applied. To accurately measure the amount of pesticides applied, average output from a 1-gal pump sprayer (Chapin International, Batavia, New York) over a period of 1 min was determined. The time spent applying pesticides to plots was measured and the actual volume applied was calculated. Pesticide costs were recorded as a proportion of the actual retail cost of purchase of those pesticides. Time spent in

managing each treatment was measured and recoded. Activities for which time will be recorded include harvesting, sampling for insect populations in IPM and organic treatments, and pesticide application. Value of time worked was calculated from hourly wage data obtained from the Bureau of Labor Statistics <http://www.bls.gov/>.

Harvest of fruit from plots was conducted twice weekly. Fruit harvested in each plot was weighed and rated as marketable or unmarketable. Weights were recorded for both marketable and total yield. Value of fruit was calculated using averages available as the National Fruit and Vegetable Retail Report of the USDA Agricultural Marketing Service (USDA Agricultural Marketing Service, 2013). The cost of management practices was subtracted from the total yield value for each plot to obtain the actual value of production.

Data in this study was analyzed by SAS v. 9.3 using PROC ANOVA and means separation (SAS Institute Inc., Cary, North Carolina). Factors evaluated using these procedures included total weight of harvested tomatoes, value of production by weight, and economic return (value of harvested tomatoes less input costs.

RESULTS AND DISCUSSION

During the Spring 2014 season, greatest mean yields of marketable fruit 15.4 kg (33.9 lbs.) were obtained from Celebrity tomatoes under the IPM management system. These yields were significantly greater than those from other treatments for both cultivars (P<0.05). Marketable yields from the Bush Early Girl IPM (29.2 lbs.) were significantly greater than those from all treatments excluding that from Celebrity tomatoes under the calendar management system (Table 1).

Table 1. Tomato cultivars, pest management strategy, marketable yield and economic returns.

Treatment	Marketable yield (lbs.)	Economic return ($USA)
Early Girl IPM	29.243±6.02 A[1]	51.98±11.63 A
Early Girl Calendar	18.248±4.06 B	28.71±8.28 B
Early Girl Organic	13.005±5.6 B	27.54±15.55 B
Celebrity IPM	33.856±6.08 A	62.02±11.83 A
Celebrity Organic	25.389±5.06 B	44.64±12.48 AB
Celebrity Calendar	19.231±4.37 B	43.38±9.87 B
IPM	31.549±6.12 A	56.99±12.12 A
Calendar	21.819±5.71 B	36.05±11.52 B
Organic	16.118±5.71 B	36.09±15.95 B

[1]Means in a column followed by the same letter are not significantly different (P<0.05).

In terms of total yield, no significant difference was observed between the two cultivars included in this study. Total yields (marketable and unmarketable) for each treatment were not significantly different (P<0.05). A greater proportion of fruit from organic treatments were determined to be unmarketable. The most frequent source of damage resulting in fruit being rated as unmarketable was associated with hemipteran pest insects with piercing-sucking mouthparts such as stinkbugs and leaf-footed bugs. These insects are effectively controlled with conventional pesticides including carbaryl and malathion. Organic pesticides did not provide effective controls against these pests.

The value of tomatoes was calculated and costs of production were subtracted from that value. During the spring season, significantly greater economic return was obtained from Bush Early Girl IPM ($52) than for other Bush Early Girl treatments (P<0.05). Total return from the Celebrity IPM treatment ($62) was greater than that for the Celebrity calendar treatment but not the Celebrity organic treatment. When considered across both cultivars, the IPM management treatment resulted in significantly greater yields [14.5 kg

(32 lbs)] and total return ($57) than other treatments (Table 1). Although a greater value per pound was given (USA$ 2.80) for organic tomatoes than conventionally grown tomatoes (USA$ 2.00), the increased value was not sufficient to counteract the reduction in marketable yield associated with less effective controls from organic pesticides. Value of time spent was calculated at an hourly rate of $9.62 <http://www.bls.gov>. This value was effectively balanced by a reduction in time spent applying pesticides to plots as well as by a reduction in the value of pesticides applied.

The initial observations of this study suggest that the adoption of principles of Integrated Pest Management (IPM) would represent a potential for increased yields and economic return for small scale vegetable producers in Mississippi. However, adoption of IPM by small scale producers is limited. The identification and elimination of barriers to this pest management system would be beneficial for these producers.

Literature Cited

Allen, W. and Rajotte, E. 1990. The changing role of extension entomology in the IPM era. Ann. Rev. Entomol. 35:379-39.

Hummela, R., Walgenbacha, J., Hoyta, D. and Kennedy, G. 2002. Effects of production system on vegetable arthropods and their natural enemies. Agric. Ecosyst. & Environ. 93:165-176.

Low, S.A. and Vogel, S. 2011. Direct and intermediated marketing of local foods in the United States, ERR-128, U.S. Department of Agriculture, Economic Research Service.

Lucas, J. 2011. Advances in plant disease and pest management. The Journal of Agricultural Science 149:91-114.

Posadas, B. 2011. Baseline economic information of the Mississippi green industry for the years 2009-2011. <http://coastal.msstate.edu/nre.html> 2013.

USDA. 2007 Census of Agriculture. Mississippi State and County Data Volume 1. Geographic Area Series: Part 24. 2009. <http://www.agcensus.usda.gov/>. 2013.

USDA Agricultural Marketing Service. 2013. National Fruit and Vegetable Retail Report. <http://www.ams.usda.gov/mnreports/fvwretail.pdf>.

Unites States Department of Labor. 2013. Occupational Employment Statistics. <http://www.bls.gov>.