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Economic Implications of the Mexican Fruit Fly Infestation in Texas

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Abstract. The Texas citrus industry is threatened by the presence of Mexican fruit fly. The objective of this study was to estimate the economic losses caused by this invasive pest. Economic impact is estimated in terms of loss in revenue and increase in operating costs. Under current quarantined areas and pest management strategies, the Texas citrus industry could experience an annual economic loss of $5.79 million. The analysis was extended to evaluate the economic impact associated with different quarantined area scenarios. This article can be used to increase awareness and adapted to estimate the economic impact of emerging invasive pest outbreaks.

INTRODUCTION

The citrus industry is an important agricultural sector in Texas. An estimated 350,000 tons of citrus were produced in Texas during the 2018–2019 growing season, representing a market value of $90 million (U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), 2019). Most of the citrus production in the state is concentrated in the southern counties of Hidalgo, Cameron, and Willacy.

Due to geographic location, Texas citrus crops are threatened by the constant inflow of Mexican fruit flies (*Anastrepha ludens*). Mexican fruit fly (commonly known as Mexfly) is native to Mexico and Central America and is an invasive pest in South Texas (Texas Department of Agriculture (TDA), 2020). Female flies lay their eggs in a broad range of fruits and vegetables but prefer grapefruit and oranges as citrus hosts (Weens et al., 2015). The damage caused by hatched larvae makes affected fruits unmarketable. However, the main hazard of Mexfly is the risk of introduction to and establishment within agricultural sectors in other regions of the country. To avoid the spread of this invasive pest, the government, in collaboration with the local citrus industry, has implemented eradication protocols within Texas, including quarantine treatments and limited movement of fruits from infested areas (Jang et al., 2015; USDA Animal and Plant Health Inspection Service (APHIS), 2016; Electronic Code of Federal Regulations (e-CFR), 2020). Preventative measures outside the quarantine zone include bait spray applications and Sterile Insect Techniques.

The Mexfly infestation in South Texas is an economic burden to the local citrus industry. Namely, it has resulted in a decrease in revenues and an increase in operating costs. The objective of this article is to assess the direct economic impacts of the Mexfly outbreaks to the Texas citrus industry. This is the first attempt to evaluate the economic implications of actual Mexfly management protocols that permit the interstate movement of citrus fruit from quarantined areas in Texas (USDA APHIS, 2016). The information presented herein can be incorporated into existing Extension programs to increase farmers' awareness about invasive species and their effects on crops (Sundermeier, 2005; Wyatt et al, 2015). Extension professionals have also identified and documented the need for tools and information related to estimating the economic impact of invasive species (Dellinger et al., 2016). To this aim, this article can serve as a reference case and educational instrument for Extension professionals to illustrate in a practical manner the intrinsic risks and potential economic losses caused by invasive pests. Additionally, the proposed valuation method can be adapted to timely analyze the economic impact of other emerging invasive pest and disease outbreaks. Lastly, the findings of this study can serve as supporting data to the assessment and development of cost-effective management strategies for nonindigenous pests.

ERADICATION PROGRAM AND PEST MANAGEMENT

There are strict protocols in place to eradicate Mexfly outbreaks in South Texas and to prevent the establishment of the pest outside of currently-infested areas (Tex. Admin.

Code, 2015; USDA APHIS, 2016; USDA APHIS, 2019). Specifically, there are three citrus system approach options available depending on whether the grove is in a quarantined area under routine preventive Sterile Insect Techniques and the grove's distance from a Mexfly detection (USDA APHIS, 2016). Compliance with the systems approach regulations to mitigate the risks imposed by the Mexfly allows interstate movement of fresh citrus fruits from the entire quarantined area. Given that most commercial citrus operations in Texas are under the USDA preventive release program of sterile flies, Systems Approach Option 1 is considered in this study (Jang et al., 2015).

Systems Approach Option 1 requires regulatory trapping and certified bait sprays to begin 30 days prior to harvest and continue through the end of harvest. Bait spray applications should be conducted weekly during the required period. The two insecticides approved under current eradication protocols are Malathion for conventional groves and Spinosad for organic groves (e-CFR, 2020). However, fruit fly systems approaches can be suspended for the remainder of the season if five or more additional flies or immature stages are detected within a core (USDA APHIS, 2016). When this happens, all fruits from groves partially or totally within the suspended cores are ineligible for interstate movement unless chemically treated, and that fruit is processed for juice. Typically, the citrus harvest season in Texas starts in October and finishes in late April. Monthly preventive bait spray applications are also conducted when eradication protocols are not active and within areas not in quarantine.

BASELINE ECONOMIC IMPACT

This economic analysis focuses only on commercial grapefruit and orange groves, as those two crops represent about 99% of the total citrus acreage in Texas. There are approximately 17,297 acres of grapefruit and 9,024 acres of oranges in the state, including 474 and 150 acres of organic grapefruit and oranges, respectively (Texas Citrus Pest and Disease Management Corporation (TCPDMC), personal communication, March 3, 2020).

At the end of the 2019–2020 harvest season, a total of 1,078.6 mi^2 were under the Mexfly quarantine in Texas, including 5,635 commercial citrus acres (TDA, 2020; TCPDMC, 2020). Furthermore, 656 commercial citrus acres were located in the cores of the quarantined area (TCPDMC, 2020). For analysis purposes, total citrus acres were proportionally allocated outside and inside of the quarantined area based on actual citrus acreage distribution (Table 1).

This paper adapts the valuation framework proposed by Zapata et al. (2018) to assess the direct economic impacts caused by the Mexfly infestation. The analysis considered a price effect, losses were stratified by citrus variety and control strategy, and the economic impact was estimated using publicly available secondary data. Generally, the overall economic impact of an invasive pest outbreak is measured by the resulting net changes in revenues and operating costs. In the case of the Mexfly outbreak, industry revenues have been affected by a reduction in the sale of fresh fruit from groves within the cores of the quarantined areas. Specifically, the pre-harvest treatments were suspended in 553.75 acres or about 84.41% of the acres within the core because five or more Mexfly larvae were found in 21 commercial groves (TCPDMC, 2020). Fresh fruit from these groves is not allowed for interstate movement; thus, it is sold at reduced citrus juice prices.

The majority of citrus produced in Texas is intended for the fresh fruit market. Based on their quality grading, fruits are marketed as fresh or processed. Small, irregular, and damaged fruits are discounted and sold as processed fruit. Yields and prices used in the analysis for conventional citrus were estimated based on the five-year average yields (i.e., 2014–2019), utilization proportions, and free on board and packinghouse-door prices reported for Texas by USDA NASS (2020). Organic yields were assumed to be 32% and

Table 1. Estimated Distribution of Commercial Citrus Acres in Texas

		Out of quarantine	In quarantine		Total
			Outside core	Within core	
Grapefruit	Conventional	13,221	3,182	419	16,823
	Organic	373	90	12	474
Oranges	Conventional	6,974	1,679	221	8,874
	Organic	118	28	4	150
Total	Conventional	20,196	4,861	640	25,697
	Organic	490	118	16	624

Note. Based on TCPDMC reported acres as of April 21, 2020. Numbers may not add up due to rounding.

Table 2. Texas Citrus Yields and Prices

		Yield (box[a]/ac)			Price ($/box)	
		Fresh	Processed	Total	Fresh	Processed
Grapefruit	Conventional	325.93	278.07	604.00	16.22	1.52
	Organic	221.63	189.09	410.72	23.10	2.16
Oranges	Conventional	337.23	128.57	465.80	15.31	1.30
	Organic	249.55	95.14	344.69	20.95	1.78

[a]Forty pounds equivalent weight.

Table 3. Mexican Fruit Fly Economic Impact

Economic impact	Preventive	Eradication		Total
		Quarantine excl. core	Core	
Revenue loss	0	0	2,639,143	2,639,143
Grapefruit	0	0	1,741,991	1,741,991
Oranges	0	0	897,153	897,153
Additional operating costs	2,866,623	223,717	57,263	3,147,602
Bait sprays	2,456,181	124,926	44,247	2,625,345
Regulatory trapping	410,441	98,791	13,016	522,248
Total economic impact	**2,866,623**	**223,717**	**2,696,406**	**5,786,746**

26% lower than conventional grapefruit and orange yields, respectively (Savage, 2015). Furthermore, based on the five-year average price differential reported by USDA Agricultural Marketing Service (2020), there were assumed price premiums of 42% for grapefruit and 37% for oranges compared to their conventional counterparts. Table 2 presents the yields and prices used in the analysis.

Under 2019–2020 infestation conditions, the Mexfly outbreak could reduce the overall annual revenue of the Texas citrus industry by $2,639,143 (Table 3). All losses come from the reduced sales of fresh fruits—calculated as the reduction in fresh fruit production multiplied by the fresh fruit price premium—from groves in the core areas affected by the suspension of the fruit fly systems approach. Specifically, the sale of fresh grapefruit could decrease by $1,741,991, while fresh oranges are expected to experience a reduction in sales of $897,153.

On the other hand, operating costs have increased due to the adoption of eradication and preventive protocols to suppress Mexfly populations (Table 3). Namely, added expenditures are given by the cost of eradication and preventive spray applications times the corresponding treated areas. Based on average rates charged by local spraying services, the cost per bait spray application is estimated at $6.00 per acre and $17.50 per acre for conventional and organic citrus groves, respectively. The implementation of mandatory eradication protocols could result in an additional statewide production cost of $169,173. Additionally, preventive insecticide applications have been adopted in about 92% of all commercial citrus acres in Texas (TCPDMC, 2020). Thus, preventive bait sprays cost an estimated additional $2,456,181. The Texas citrus industry also contributes $522,248 annually to support TDA and USDA regulatory Mexfly trapping efforts. For estimation purposes, industry trapping expenses are proportionally allocated based on the current distribution of commercial acres under eradication and preventive regimes. Overall, the total direct economic impact associated with the observed 2019–2020 Mexfly infestation is estimated to be equal to $5,786,746.

ALTERNATIVE QUARANTINE SCENARIOS

Given the rapid evolution of the infestation, it is important to assess the economic implications of potential modification to the Mexfly quarantine areas and their corresponding core areas. To this aim, I conducted a sensitivity analysis to eval-

uate the economic impact associated with different combinations of total commercial citrus acreage under quarantine, proportion of citrus acres in core areas, and the percentage of core acres with suspended fruit fly system approaches. I evaluated different scenarios based on five potential quarantine zones affecting 0%, 25% (6,580 ac), 50% (13,161 ac), 75% (19,741 ac), and 100% (26,321 ac) of the overall Texas commercial citrus acreage. For each quarantine scenario, I considered three core areas enclosing a total of 5%, 15%, and 25% of the citrus acres within the quarantined area, as well as five potential fruit fly systems approach suspension levels in 25% increments (Table 4). All other parameters and assumptions were equal to the ones described in the previous section. A limitation of the proposed sensibility analysis is its static nature. In practice, the core and quarantined areas, as well as the number of acres with suspended systems approaches, change throughout the growing season.

If Mexfly was eradicated and all related quarantined areas and mandatory eradication protocols were removed in Texas, the citrus industry would still face a total annual economic impact of $1.98 million due to the continuation of preventive actions (Table 4). The total economic burden imposed by the pest increases as more commercial citrus acres are directly affected by the quarantine and by the suspension of the fruit fly systems approaches. For instance, when the systems approaches are active on all citrus acres within the core, no revenue losses are expected and all the economic impact is generated by the adoption of preventive and eradication protocols. With active systems approaches in place, the total economic impact ranges from $3.81 million to $9.29 million when 25% and 100% of the total citrus acreage is quarantined, respectively. On the other hand, total economic losses substantially increase as the overall number of commercial citrus acres with suspended fruit fly systems approaches rises. For example, overall losses could be equal to $39.68 million (i.e., $31.38 million due to revenue loss and $8.30 million in additional operating costs) if the systems approaches are suspended in 25% of the Texas citrus commercial acreage.

SUMMARY AND CONCLUSIONS

In this article I assessed the direct economic impact caused by the Mexican fruit fly outbreak to the Texas citrus industry. I estimated the economic impact in terms of the loss in revenue and increase in operating costs. A reduction in the value of sales is observed when certified pre-harvest treatments are suspended on citrus groves located within the core of the quarantined areas. Furthermore, additional expenses are generated by the adoption of Mexfly eradication and preventive protocols. I estimated that under 2019–2020 quarantined areas and current pest management strategies, the Texas citrus industry could experience an annual economic impact of $5.79 million, consisting of $2.64 million in rev-

Table 4. Overall Economic Impact of Alternative Infestation Scenarios Evaluated

Proportion of core acres with suspended systems approaches	Quarantined acres						
	0	6,580			13,161		
	Proportion of acres in core						
	0%	5%	15%	25%	5%	15%	25%
	million dollars						
0%	1.98	3.81	3.81	3.81	5.64	5.64	5.64
25%		4.19	4.95	5.71	6.39	7.91	9.43
50%		4.57	6.09	7.61	7.15	10.19	13.23
75%		4.95	7.23	9.51	7.91	12.47	17.03
100%		5.33	8.37	11.41	8.67	14.75	20.83
			19,741			26,321	
0%		7.46	7.46	7.46	9.29	9.29	9.29
25%		8.60	10.88	13.16	10.81	13.85	16.89
50%		9.74	14.30	18.86	12.33	18.41	24.48
75%		10.88	17.72	24.56	13.85	22.96	32.08
100%		12.02	21.14	30.25	15.37	27.52	39.68

enue loss and $3.15 million in added operating costs. Also, the magnitude of the economic impact increased as the total citrus acreage affected by the quarantine and the number of core acres with suspended fruit fly systems approaches increased. Particularly, if the Mexfly quarantine is removed, preventive infestation actions could still result in a total annual cost of $1.98 million. Contrarily, the economic losses associated with more severe infestation situations could be at least $39.68 million.

The economic impacts presented in this article can be used by Extension professionals to increase awareness about the devastating effects that invasive pests can cause to local economies. The findings highlight the inherent risk associated with the rapid spread of non-native species and the need to develop comprehensive control plans. In this regard, Extension professionals, scientists, industry organizations, and government agencies need to work together to develop and promote cost-effective, research-based pest management strategies. Additionally, the valuation method considered can easily be adapted to promptly assess the economic impact of future pest outbreaks. A timely assessment of the potential risks imposed by novel invasive species is important to implement proper mitigation actions.

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