CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
SPECIALTY CROP BLOCK GRANT PROGRAM
PROGRESS REPORT

USDA PROJECT NO.:	PROJECT TITLE:	
59	Biological Control of Brown Marmorated Stink Bug, Halyomorpha Halys (Pentatomidae)	
GRANT RECIPIENT: California Department of Food and Agriculture	**GRANT AGREEMENT NO.:** SCB16059	**DATE SUBMITTED:** December 2017
RECIPIENT CONTACT: Charles H. Pickett	**TELEPHONE:** (916) 262-2053	**EMAIL:** charlie.pickett@cdfa.ca.gov

FEDERAL EXPENDITURES

Cost Category	Amount Approved in Budget	Actual Federal Expenditures (Federal Funds ONLY)
Personnel	$78,891.00	$51,376.30
Fringe Benefits	$26,577.00	$24,957.78
Travel	$15,343.00	$2,021.42
Equipment	$0.00	$0.00
Supplies	$5,397.00	$133.55
Contractual	$314,757.00	$33,963.24
Other	$1,200.00	$0.00
Direct Costs Sub-Total	$442,165.00	$112,452.29
Indirect Costs	$0.00	$0.00
Total Federal Costs	$442,165.00	$50,966.36

PROGRAM INCOME

Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
No program income.	$0.00	$0.00
	$0.00	$0.00
	$0.00	$0.00
Total Program Income Earned	$0.00	$0.00

ACCOMPLISHMENTS

OCTOBER 2016 – MARCH 2017

The estimated total percentage of work completed on this project……..…….……10%

List Objective or Outcome/Indicator Number	Accomplishment
Objective 1: Complete host specificity testing for *T. japonicas*, a novel, two millimeters in length parasitoid from China that attacks the eggs of Brown Marmorated Stink Bug (BMSB).	An Agricultural Technician and a Laboratory Technician were hired. An additional ~120 replicates (approximately 3,360 eggs) were processed since October 2016 for non-targets *Chlorochroa uhleri, Thyanta pallidovirens, Mecidea* sp., *Podisus maculiventris, Nezara viridula, Banasa dimidiata*. Current results for replicates combined (now in the 200 series) indicated a selective ability by *T. japonicus* to attack BMSB. The objective of this field season was to conclude safety testing for *Antheminia remota* and *Agonoscelis puberula*; these species were difficult to rear in the lab.
Objective 2: Survey California for resident parasitoids capable of attacking BMSB.	BMSB egg producing colonies were initiated. These were needed to provide eggs for sentinel egg mass cards. Monitoring traps and associated sentinel cards were set up throughout the range of this pest in California. To date: 34 in central and southern California, and 29 in northern California. These will help determine what parasitoids were attacking BMSB in California, to what extent, and what predation was taking place. They will also identify if the exotic *T. japonicus*, a specialist of BMSB, is in the state. Locations with high predation will be determined and cameras set up to identify these to at least the family level.

APRIL – SEPTEMBER 2017

The estimated total percentage of work completed on this project ……..…. 40%

List Objective or Outcome/Indicator Number	Accomplishment
Objective 1: Complete host specificity testing for *T. japonicas*, a novel, two millimeters in length parasitoid from China that attacks the eggs of Brown Marmorated Stink Bug (BMSB).	Host specificity testing commenced. These tests were conducted to determine whether the candidate parasitoid *T. japonicus* was safe to release into the environment, i.e. doesn't attack stink bugs other than BMSB. Under this experimental framework 227 no-choice replicate sets (i.e., 454 drams, 12, 234 target and non-target eggs) had been set up during FY14-FY16 to study the physiological host range of *T. japonicus*. A total of 2,822 target/non-target eggs were dissected and these data were added to combined safety testing results. Adult parasitoid emergence results for no-choice replicates indicated

List Objective or Outcome/Indicator Number	Accomplishment
	that egg masses of *A. remota*, *B. dimidiata*, *P. maculiventris*, *Mecidea* sp., *Euschistus* sp., and *T. pallidovirens* are, in some cases, successfully parasitized by mated *T. japonicus* females and will produce both male and female F1 progeny, albeit of a relatively small size in comparison to parasitoids that emerge from BMSB eggs. Overall, it was not clear whether *T. japonicus* could maintain viable populations for several generations on these non-target species. This possibility warranted future investigation. Interestingly, *N. viridula*, *B. hilaris*, and *A. puberula* were not successfully parasitized by *T. japonicus* nor was there direct evidence of mortality resulting from attempted parasitism by *T. japonicus* (detected as undeveloped parasitoids) on these non-target hosts.
Objective 2: Survey California for resident parasitoids capable of attacking BMSB.	Sentinel cards were deployed throughout the state for two reasons: first to determine what native parasitoids could be attacking BMSB; and secondly to determine if the candidate parasitoid *T. japonicus*, now present in Oregon, had spread into California. A total of 49 sites were identified for sentinel egg cards in California. Four sites in Los Angeles County, nine in central California, and 36 in northern California. Most included pheromone baited traps to help draw in parasitoids but also to determine if various crops were at risk to attack by BMSB. Sites included public/non-profit parks and gardens, private homes, and on the perimeters of commercially planted citrus, peach, apple, walnut, kiwifruit, cherry, almond, pomegranate, and avocado. In total 729 sentinel cards each with approximately 28 eggs, had been deployed and retrieved throughout the state. At six of these locations, a time lapse field camera had been set up to help identify predators and parasitoids attacking sentinel eggs. An upgraded model of camera was purchased for this goal that had a higher level of resolution. This made it possible to identify to family and even genus, species of parasitoids attacking eggs. Identification of emerging adult parasitoids is accomplished using

List Objective or Outcome/Indicator Number	Accomplishment
	adult parasitoids emerging from eggs and traditional morphological characteristics.
Outcome 4: Enhance the competitiveness of specialty crops through greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources. Indicator 2: Adoption of best practices and technologies resulting in increased yields, reduced inputs, increased efficiency, increased economic return, and conservation of resources.	Field releases of *T. japonicus* have not been possible to date as initially projected. Host specificity data (dissection results; see objective 1) were still in the process of being compiled for analyses. Fortunately, these experiments have been completed. A manuscript that would present these data was prepared for journal publication. This effort should facilitate the approval of a future request for release/movement of *T. japonicus* in California. This pending publication should be available by late 2018. In turn, the availability of *T. japonicus* to growers is expected to reduce the need for pesticide applications (reduced pest management costs) because this natural enemy can disperse naturally and target BMSB egg masses early in the spring when the growing season begins for most crops in the state. It is important to note that *T. japonicus* was self-introduced to Oregon and Washington. In those states, permits have been secured to assist the establishment (movement between sites) of *T. japonicus*. Consequently, it is only a matter of time before *T. japonicus* makes it way to California. The host specificity tests are still essential to ensure that native and endemic stink bugs will not be negatively impacted by the presence of *T. japonicus* in California habitats. Sentinel egg cards have been placed throughout the state to capture any *T. japonicus* that may be entering California on their own, either from Oregon or commerce. This last year, cards that had been placed in San Jose and Yreka only yielded native parasitoids. This could change soon since the state of Oregon will be releasing *T. japonicus* along its southern border.
Outcome 5: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems.	Information on the threat of BMSB to California agriculture has been extended to stakeholders through academic publications, online postings, weblogs, and professional presentations.

List Objective or Outcome/Indicator Number	Accomplishment
Indicator 8: 46,000 growers/producers that gained knowledge about science-based tools through outreach and education programs.	Specifically, two peer-reviewed journal publications focused on the threat BMSB poses to California pistachios (Lara et al. 2017; DOI: 10.1093/jisesa/iex084) and kiwifruit (Lara et al. 2018; DOI: 10.1080/00779962.2018.1438758). An additional group publication by Abram et al. (2017) focused on the potential prospects of relying on resident natural enemies from North America for BMSB control (DOI: 10.1007/s10340-017-0891-7). Updates were also made to stakeholders through Western Farm Press (article 2017. article 2018), the Center For Invasive Species Research (CISR) at UCR (updated BMSB distribution map), and through professional presentations (ESA, November 2017 presentation #1208). Recently, two additional publications discussing applied BMSB management were also made available. One publication was through the California Pest Control Adviser (volume 31, pg. 44-48) and the second one was published in Spanish through the Center for Invasive Species Research (CISR) (direct link here). The latter was the first effort to communicate extensive BMSB research findings to Spanish-speaking audiences in the United States and abroad; which was a significant milestone. Furthermore, oral presentations were given to both industry and scientific communities: • Heteroptera Symposium, Monterey, April 2017 (200 attendees) • Pacific Branch Entomological Society of America, Portland, OR, April 2017 (100 attendees) • 101th Pacific Branch, Entomological Society of America Annual Meeting, Portland, OR, April 2017 (35 attendees) • Western Regional Biological Control Working Group, Anza Borego Springs,

List Objective or Outcome/Indicator Number	Accomplishment
	October 2017 (60 attendees) • California Food Processors annual meeting, Stockton, November 2017 (50 attendees) • Entomological Society of America's 65th Annual Meeting, Denver, CO. November 2017 (50 attendees) The University of Riverside website for BMSB received 3,910 views for the English version, and 98 for Spanish version since January 2017. These collective outreach and extension efforts have helped to ensure California stakeholders have stayed informed of the latest BMSB management recommendations (i.e., monitoring and use of natural enemies) and ultimately for California specialty crop systems to remain competitive.

CHALLENGES AND DEVELOPMENTS

OCTOBER 2016 – MARCH 2017

Challenges	Corrective Action and/or Project Change(s)
Lost a highly trained technician to retirement.	An Agricultural Technician and a Laboratory Technician were hired before the former technician retired to cross train new staff. It is expected that all project objectives and expected outcomes will still be met within the duration of the grant. Hired two technicians before former one retired to cross train new staff.

Positive Developments	Project Change(s)
None	

APRIL – SEPTEMBER 2017

Challenges	Corrective Action and/or Project Change(s)
None	

Challenges	Corrective Action and/or Project Change(s)
Low expenditures.	Low expenditures were primarily due to a delay in billing. This delay has been remedied. The Budget Narrative in the Scope of Work was revised to ensure that all great funds would be expended within the duration of the project. See Attachment 1 for more detail. The Expected Measurable Outcomes and project Objectives are still expected to be completed as planned. CDFA is working closely with the recipient to monitor the level of expenditures. The project is still on schedule to be completed as planned.

Positive Developments	Project Change(s)
None	

SOLELY ENHANCING THE COMPETITIVENESS OF SPECIALTY CROPS

OCTOBER 2016 – MARCH 2017

Staff reported their time worked by project code. All project expenditures were tracked to ensure that they solely enhanced the competitiveness of specialty crops.

APRIL – SEPTEMBER 2017

Personnel time worked was broken down by project. All project expenditures were tracked and reviewed to ensure that they were used to solely enhance the competitiveness of specialty crops.