Final Project Report

Prosapia bicincta (Two-lined Spittlebug) Detection and Control in Hawaii
Contract No. 65973

For the Period of
August 16, 2017 – October 1, 2019

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Progress Report

This report covers the project period beginning August 16, 2017 through October 1, 2019. The work describe herein was completed through multiple funding sources including this contract (HISC, C81112; $50,000), a contract with Hawaii County ($25,000) and the Hawaii Dept. of Agriculture (contract no. 65973; $300,000). Collectively, the objectives of the work under these three funding sources were to 1) provide rancher outreach and education; 2) conduct surveys to detect and monitor TLSB populations; 3) develop Integrated Pest Management (IPM) protocols (Pesticides, Grazing management, Forage replacement); 4) conduct biological control agent exploration; and 5) research the biology and ecology of Two-lined spittlebug (TLSB). The work and deliverables of each of these objectives are discussed in the following sections. The attached appendix includes pictures of TLSB damaged pastures and example data output from the project.

Two-lined spittlebug was first detected in Kailua-Kona, on the Big Island of Hawaii in September of 2016 where it had caused damage to nearly 2,000 acres of pasture land. Monthly pasture surveys that began in in November of 2017 have revealed that the pest has rapidly expanded its range and as of October of 2019 infests over 222 sq. miles or about 142,468 acres (Figure 1). In highly infested areas, the TLSB has resulted in nearly 100% die back of key pasture grasses including Kikuyu (*Pennisetum clandestinum*) and pangola (*Digitaria eriantha*) grasses. The loss of these important livestock forages provides entry for the establishment of many undesirable, and often invasive plants including Pamakani (*Eupatorium adenophorum*), wild blackberry (*Rubus* spp.), fireweed (*Senecio madagascariensis*), Hilo grass (*Paspalum conjugatum*), several other minor grasses of low forage quality, and other weeds. The weeds tend to replace the dead grasses permanently, reducing the quality and usability of the pasture for livestock production. The rate of spread of this pest combined with its devastating impacts on Hawaii's rangelands threatens the economic sustainability of the Hawaii livestock industry.

Rancher Outreach and Education

Rancher outreach and education has included the publication of a TLSB pest alert, and an update distributed through the Hawaii Cattlemen's Council (HCC) meetings and at CTAHR extension workshops. An educational workshop was held May 14, 2018 in Kona for cooperating producers, HDOA Plant Pest Control Branch personnel, and UH Faculty. Educational presentations were provided to ranchers across the state at the 2017 and 2018 HCC Annual meetings, and at the joint mid-year meeting of the HCC/Hawaii Cattlemen's Association meetings in June of 2017 and 2018. The TLSB team provided a field day/pasture walk training for USDA-NRCS field personnel on the identification and detection of TLSB in pastures. A poster on TLSB in Hawaii was presented at the 2019 Annual meeting of the Society for Range Management, and at the Ag Day at the Capital in February. Monthly reports of the survey data are compiled and provided to the cooperating ranches, and HDOA-Plant Pest Control Branch personnel. Finally, an informational rack card was produced (5000 copies) in cooperation with the Big Island Invasive Species Council and distributed throughout Hawaii County to raise awareness of the pest.

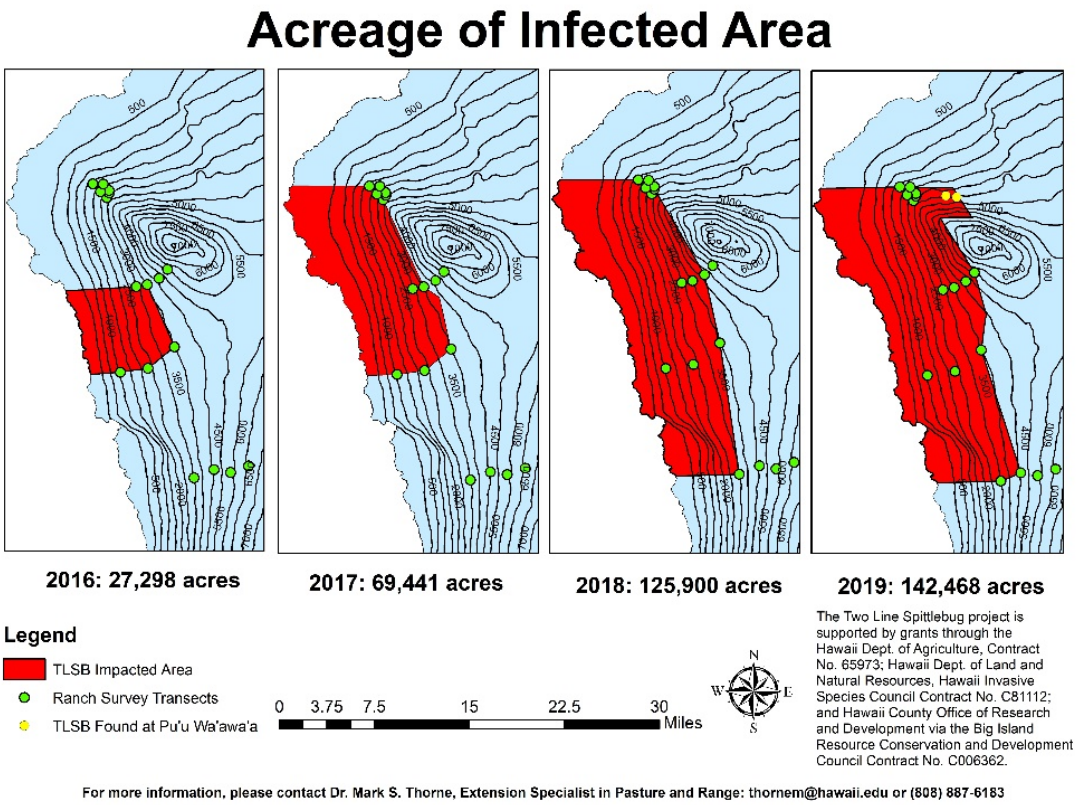

Figure 1. Spread of Two-line Spittlebug from the first identification in pastures above Kailua-Kona in 2016 to current (October 2019). Green dots represent locations of project survey transects monitored monthly. Yellow dots represent the locations of known populations of TLSB in Puʻu Waʻa Waʻa.

Field Surveys – Detection and Surveillance

In October/November of 2017 the project team established five Two-line Spittlebug (TLSB) transects on each of two ranches in the North Kona area where the bug had been reported along an elevational gradient from 2,000 to 5,000 ft above sea level. Spittlebug larva and adult numbers were quantified and collected from the transects. With funding, a recruitment for a Research Technician and two graduate students was initiated in October 2017. One Graduate Student position was filled in early January 2018 and the research technician position was filled on January 17, 2018. The filling of these positions allowed expansion of the area under surveillance with the establishment of additional transects. The new transects were established on two additional ranches, one where spittlebug activity had been previously documented, and a second ranch further south, where no spittlebug activity had been reported. Monthly surveys of all the transects on all four locations began in February 2018.

The addition of these two locations allowed us to bracket both the northern and southern extents of the TLSB infestation by fall of 2018. Until late in August of 2019 subsequent surveys further north and south of our monitoring sites had not detected TLSB activity. However, following a report of TLSB activity in Puʻu Waʻa Waʻa a scouting expedition was mounted that located two

TLSB populations. We continue to scout for new populations along the northern boundary of the current TSLB distribution to monitor spread. However, without specific steps to control the current infestation we expect the bug to continue to expand its range.

Transect Sampling: Ten 0.25 m^2 observation points are located at 10 m intervals along each 100 m transect at each of the four monitoring sites. Data collected in 0.25 m^2 observation points include a count and collection of TLSB nymphs and adults; identification and count of the number of plant species present; an estimate of canopy cover and height by growth form (grass, forb, shrub), and an estimate of damage (grass dieback) by grass species, using standard rangeland assessment procedures. This data has allowed us to gain an understanding of the biology and ecology of TLSB in Hawaii (objective 5) in terms of habitat selection, life-cycle, and seasonal abundance, along with the impacts of the bug on the composition of plant species in Hawaii rangelands. This knowledge will be valuable in the development of Integrated Pest Management Strategies.

Integrated Pest Management Protocols

Work on this objective is still underway. Through our field observations and literature reviews of TLSB behavior elsewhere we have compiled a short preliminary list of Integrated Pest Management (IPM) strategies for ranchers and homeowners. These are being compiled and will be published in extension documents in the near future. Below is a summary of our preliminary IPM strategies for TLSB in pasture areas and for homeowners:

For ranchers with extensive areas infested, grazing management strategies are the most cost effective, while reserving high cost strategies (pesticides) for targeting critical areas or new (small) infestations. Grazing strategies include implementing heavy grazing at the earliest detection (nymph stage) to reduce suitable habitat for both the nymphs and adults followed by extended rest of the pastures to allow for recovery of the forages. These intense grazing bouts may need to be repeated two or three times during the summer months (peak TLSB activity) until the bug goes into diapause (usually October/November). Pesticides are available for spittlebug control in pastures. Many are restricted use, but several are not. Due the cost and potential collateral damage of pesticides it is recommended that ranchers use pesticides strategically to target key use areas and/or where there are new, small outbreaks of TLSB. Heavily damaged pastures should be seeded with one or more resistant varieties of forage grasses as soon as possible to help suppress competing weeds and recover forage quality of the pasture.

For home owners it is recommended to reduce watering as this will help dry out the underlying soil-bed reducing the suitability of the habitat of nymph survival. Additionally, the lawn should be kept short as this will reduce nymph and adult habitat. Reducing adult feeding sites can have significant impacts on reducing feeding damage. Non-restricted use pesticides can be used to spot treat observed nymph infestations or where adult activity has resulted in dead patches of grass in the lawn.

Biological Control Agent Exploration

Working with a plant pathologist from the USDA-ARS laboratory in Hilo, Hawaii, an indigenous insect-pathogenic nematode has been identified that, thus far, under laboratory conditions will infect TLSB nymphs resulting in their death. The nematode is found along the beach strand at the transition between the beach sand to the upland soils in Hawaii. It is not clear if it is found at higher elevations. Initial field trials were conducted to determine if the nematode could be delivered either as a spray of a water-based solution or in the cadaver of wax moth nymphs. The trials failed to produce any infected TLSB nymphs in the treatment plots in the field. However, we were able to detect the nematodes in soil samples collected from the plots several weeks later. Thus, the nematode holds promise as a locally derived biological control if we can determine an effective and economical method to deliver them to TLSB infestations.

During a survey at one of our ranch locations in August 2019 we discovered adult TLSB cadavers attached to grass leaf blades. Some were in a resting posture while others had their wings spread wide. This anomaly was identified as the activity of a parasitic fungi that attacks insects by Dr. Dan Peck, who is an expert on spittlebugs, and until recently worked for a biopesticide company specializing using similar species of fungi as a biopesticide. The fungi attack the insect and drive them to the top of the plant leaf where they die. In the process of their death the fungi send out hyphae to attach the cadaver to the plant. As the cadaver ages the wings of the bug open to facilitate the spread of the fungal spores. A sample was sent to the USDA-ARS laboratory in Ithaca, NY where entomopathogen specialists area based out to attempt to identify the fungus responsible for the activity we observed, however the results have not come back yet. While this has only been observed in one location and spatially over only a very small area, it is exciting to think of the possibility of what this fungus may represent if widespread infections of TLSB occur.

Two-line Spittlebug Biology and Ecology

In addition to the data collected in the monthly surveys, laboratory/greenhouse studies provide critical evidence in the biology and ecology of the TLSB. Studies underway include host plant specificity trials, nymph survival trials on an array of grass species, and adult/nymph density threshold trials. As these trials are ongoing and specific results are not yet available. However, the results will provide needed information on TLSB selectivity for different grass varieties and the tolerance of those varieties to TLSB attack. The adult density trials will provide valuable evidence for economic thresholds for implementation of different Integrated Pest Management Strategies

Recommendations for Future Actions

The introduction of TLSB to Hawaii threatens the sustainability of the livestock industry in state and poses a significant ecological challenge to the management and conservation of land resources. The pest is spreading quickly and in outbreak areas the populations of TLSB grow, so far, unchecked by environmental constraints that likely limit its impacts in its home range, such as climate, resistant grasses, and predators. The result is that where the outbreaks are large there is nearly a 100% loss in the desirable forage grasses that provide feed for grazing livestock, and cover to suppress weeds, prevent erosion, and slow water runoff. At the current rate of spread,

approximately 35,000 acres per year, it will likely reach the economically critical ranch lands of the Waimea/Kohala region within the next 10 years. This is assuming it is not transported there in a vehicle, or through the movement of plant materials from the Kona area. This of course is a major concern. Sod is grown in Kona and Kohala and, along with other ornamental plants, liberally transported throughout the island for landscaping projects at resorts, golf courses and homes. Thus, while the natural spread of the pest might take as much as 10 years to reach Waimea/Kohala ranch lands, the accidental introduction through human activity will likely occur much sooner.

The continued funding of our project is valuable and will provide important information to the management and control of TLSB along with mitigation practices in severely impacted lands. Further, it is our objective to raise awareness of the devastating potential of this pest in Hawaii. However, this project alone is not enough. It is our recommendation that the State adopt and aggressive plan to combat this pest, much like its efforts addressing Rapid Ohia Death or the Coqui frogs, involving HDOA, DLNR and other relevant state agencies. These efforts need to focus on vigorous inspection and control of the movement of plant materials within Hawaii County and between counties within the state. Further, the state should consider working closely with federal agencies to align research priorities onto TLSB (USDA-Agricultural Research Service) and rancher subsidy programs (USDA-NRCS; USDA-FSA) to mitigate the impacts of the pest. Already the USDA-NRCS, in recognition of the severity of the impact of TLSB to ranches in the Kona area, has implemented a program to help affected ranchers purchase grass seed to reseed impacted rangelands. While this program is relatively small and limited in scope, it provides a valuable tool and some hope to affected ranchers. It would be valuable for the state to ally itself to these efforts.

Appendix

Figure 1. Two-line Spittle Bug adult (top) and nymphs in spittle mass found along grass roots just below the soil surface. Both the adult and nymph feed on the xylem (nymphs) and phloem (Adults) of the plant. Adults inject amylase into the plant that interferes with photosynthesis resulting in leaf die-back and in severe cases, plant death.

Figure 2. Rangeland damaged by Two-Line Spittlebug in the mauka lands of Kailua-Kona. Two-line Spittlebug densities greater than 50 nymphs/m^2 consistently resulted in the dieback of Kikuyu and Pangola grasses (top) leading to the likely irreversible invasion of weeds such as Pamakani, fireweed, blackberry and many others (bottom).

Figure 3. Progression of a TLSB infestation from initial attack (left, June 2018) on healthy range grasses involving a small patch to all visible range infested (right, January 2019) with dieback of grasses and increasing weed infestation. Applications of pesticides and intensive grazing in the early stage of an infestation may prevent the degree of TLSB damage progressing to that observed on the right.

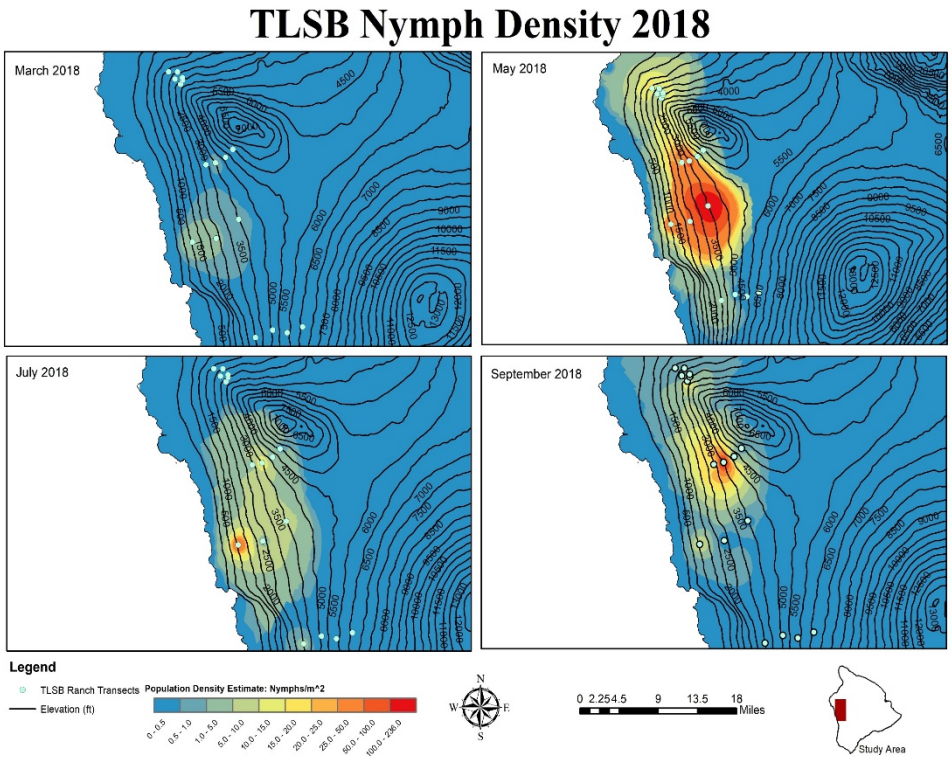

Figure 4. Map series showing the change in TLSB nymph densities between March and September of 2018. Note bimodal peak in densities (May and September). The pest entered diapause over the winters of 2017 and 2018.