TITLE: Integration of bio-pesticides into sustainable insect pest management in fruit.

PERSONNEL: Greg Krawczyk, Ph. D.
Extension Tree Fruit Entomologist
Penn State University, Department of Entomology
Penn State Fruit Research and Extension Center
Biglerville, PA 17307-0330
Ph: (717) 677-6116 Ext. 5
e-mail: gxk13@psu.edu

PROJECT DURATION: Two Years, 2nd year project funding request

JUSTIFICATION:
Insect pest complex on tree fruit consists of over twenty different insects capable to damage fruit and/or significantly reduce the marketable value of the crop. The presence of codling moth, *Cydia pomonella* or oriental fruit moth *Grapholita molesta* larvae eliminates fruit not only from the fresh market but makes them unacceptable also for the processing. The introduction of brown marmorated stink bug (BMSB) (*Halyomorpha halys*) made the pest management more challenging and forced growers into increased usage of broad spectrum insecticides and consequently contributed to re-occurrence of many secondary pests.

In its native range in Asia, BMSB is not considered an important pest of agricultural crops. With a spectrum of close to 200 host plant species, BMSB is feeding on both, wild and cultivated plants. The potential outbreaks in cultivated crops are normally minimized by effective biological control agents reducing the numbers of individuals before they reach catastrophic numbers. A parasitic wasp native to Asia, *Trissolcus japonicus* feeding on BMSB egg masses is capable to kill up to 70 percent of eggs. Under our conditions, the complex of parasitic wasps controlling our native stink bugs so far is not able to adapt to BMSB eggs and although some of them sporadically also attack the BMSB egg masses, the efficacy of such control is still very low, less than 10 percent. However, during the last few seasons, we observed isolated individuals of *T. japonicus* present on wild vegetation and around orchards in Pennsylvania. Although these findings are still infrequent, there is a good chance *T. japonicus* become established in our region and potentially will become as important for the natural management of BMSB as it is in its native range in Asia. Unfortunately, the currently employed insecticides for the control of BMSB are also toxic to most beneficial organisms including parasitoids.

Utilization of Integrated Pest Management (IPM) practices exemplifies the best options to prevent economic losses and to minimalize adverse effects of biotic and abiotic factors affecting crop production. Incorporation of biological control agents (beneficial organisms), disease resistant cultivars, mating disruption or cultural pest management practices are the main venues to replace or at least reduce the use of synthetic pesticides to manage disease and insect pests. One of the less explored ways to reduce the past dependency on synthetic pesticides is to increase the adoption of alternative, less toxic products called bio-pesticides or bio-rational products. Bio-rational products used for pest and disease management are generally described as

materials derived from natural sources such as plant extracts or natural toxins and which usually represent lower negative impact on environment. The official EPA definition identifies bio-pesticides as having "fundamentally different modes of action" and "lower risks of adverse effects" than conventional (i.e. neurotoxin) pesticides. In the latest update of the Penn State Tree Fruit Production Guide in addition to detailed description of various mating disruption products, a number of additional bio-rational products are listed along of systemic pesticides. Insecticides such as Grandevo (*Chromabacterium substsugae*), Venerate (*Burholderia* spp) or Tarsus (natural pyrethrins) are recommended for the control of many insect pests. Currently, the main challenges with wider adoption of such products are associated mostly with a relative absence of practical recommendations and understanding of their benefits. While the efficacy of synthetic pesticides is well studied and reported frequently as pest mortality or disease control levels, the practical efficacy of bio-rational products is more difficult to fully assess and understand. While the direct pest mortalities caused by the bio-rationals frequently appear lower than one caused by synthetic pesticides, this judgement is often associated with challenges to correctly assess additional long term positive effects of these compounds on target pests and other species in the system and how their selectivity benefits beneficial insects and pollinators.
Additionally, our recent intensive evaluations of insecticide treated nets for the control of BMSB generated very promising data on the efficacy of nets not only for the control of BMSB, but also for the spotted lanternfly (*Lycorma delicatula*) and high potential for such pests as Japanese beetle (*Popilia japonica*) and plum curculio (*Conotrachelus nenuphar*).

With a rapid increase in the numbers of costumers purchasing fresh products directly from farmers either through the farmer's markets or roadside farm markets, the customers are increasingly interested in understanding of the production practices utilized by farmers. Although for many customers, buying organic produces is usually the ultimate goal, the understanding of environmental challenges associated with organic production in our NE US region, customers usually have no problem to settle for local fruit and vegetables produced with a minimum input of synthetic pesticides. The grower's desire to a minimalize the use of synthetic pesticides and, if needed, their replacement with various alternative tactics (e.g., bio-rationals) can leads to food products almost free from fresh pesticide residues.

Our 2020 season observations conducted in three commercial fruit orchards documented the efficacy and usefulness of bio-rational products in the management of some fruit pests. Mating disruption applied against codling moth and oriental fruit moth complex in combination with ghost traps utilizing long lasting insecticide treated nets baited with plum curculio, then Japanese beetle and then BMSB lures provided very effective control of targeted pests. The monitoring of these and other pests with pheromone traps provided directions for the needed insecticide applications. None of the orchards employing above tactics used synthetic insecticides from August to harvest, however some bio-rational products (such as Madex HP) were used as the late season efficacy of mating disruption become questionable.

During this season continuation of the project, we propose to continue the validation of practices to reduce the reliance on synthetic pesticides by increased adoption of available bio-rational tools in fruit production. The second year activities should help us to re-evaluate and confirm our year one results and when possible, improve the efficacy of applied pest management tactics.

OBJECTIVES:
Objective 1. Evaluate the efficacy of diverse usage patterns of bio-rational products in pome and stone fruit orchards.

Objective 2. Document the beneficial impact of usage of bio-pesticides on beneficial insect conservation and enhancement of pollinator populations in and around orchards.

Objective 3. Communicate the results of the project directly to farmers through special on site demonstrations, extension publications and web based resources.

WORK STATEMENT:
In our project we propose to continue the development of pest management practices in which bio-rational products (including mating disruption, bio-pesticides and insecticide treated nets) are fully incorporated into insect management systems in fruit and are utilized as substitutions to synthetic pesticides. The special emphasis will be placed on full elimination of synthetic pesticides in the second part of the season, so the produced fruit crop can be claimed as "synthetic insecticide free" for the last "*x"* number of days, weeks or months before harvest. To achieve this goal, the seasonal pest and disease control practices will be based on monitoring and utilization of non-pesticidal practices such as mating disruption (CM and OFM), insecticidal nets (BMSB, JB, PC, AM) or bio-pesticides (TABM, OBLR) for controlling various insect pests. The overall use of synthetic pesticides will be limited and considered only for the use during the early part of the season.

The research/demonstrational plots will continue to be located in three commercial grower orchards marketing their fruit directly to the costumers and localized in distinctively separated fruit growing regions of Pennsylvania. The insect pest management and monitoring practices will be implemented at each location. The insect pest monitoring activities will include standard monitoring practices for codling moth, oriental fruit moth, tufted apple bud moth, *Platynota idaeusalis*, obliquebanded leafroller, *Choristoneura rosaceana*, spotted tentiform leafminer, *Phyllonorycter blancardella*, Japanese beetle and brown marmorated stink bug. The insect management practices will be based on the best IPM practices. No synthetic insecticides will be used in any of the block within approximately 30-60 days before the harvest. During that period, if a corrective treatment will be necessary, then only the appropriate bio-pesticide will be utilized. The fruit quality data will be collected at mid-season and during the harvest. To compare the results of the novel practices with standard procedures, a separate block with standard IPM based management practices will be used as a control block at each location. All insect monitoring activities and fruit evaluations will be done the same as in the bio-pesticide orchards.
If possible, the on-site educational meetings will be organized during the second season at each individual site and the results of the project will be disseminated to participants. The results of the project will also be prepared for presentation and publication through the extension channels such as PSU Fruit Times Newsletter and winter educational meetings. If feasible, at the conclusion of each educational meeting presenting the results of the project, a survey will be

distributed to participants to evaluate their perception and potential impact of the proposed new pest management activities on the market opportunities. If possible, a survey of random costumers visiting each grower's market will be conducted to evaluate the consumer perception of various management practices and questions will be asked about their preferences.

BUDGET – Year 2:

Technician salary 0.25 FTE (data collections, colonies maintenance, etc. …)	*$ 9,324*
Wages:	*$ 2,500*
Fringe benefit (*@ 34.88 %)*	*$ 3,252*
Fringe benefit (@ 7.94 %)	*$ 198*
Travel (4 months fleet operation vehicle lease @ $865/month, plus overnight accommodation at research sites, etc.)	*$ 3,800*
Supplies (e.g., insect trapping and monitoring supplies, insect colonies, greenhouse fees at FREC, etc.)	*$ 2,000*
TOTAL for the 2nd year of the project:	**$ 21,074**

DURATION OF PROJECT: 2020 - 2022

Year 2: April 01, 2021 – March 31, 2022 $ 21,074

SUBMITTED BY:

Greg Krawczyk, Ph.D.
Principal Investigator

Other support: Researcher salary and some clerical support are provided by The Pennsylvania State University College of Agricultural Sciences.