Chapter 5

Summary

In the northeastern and Mid-Atlantic states, alfalfa weevil, *Hypera postica*, is under almost complete biological control (Day 1981, Kingsley et al. 1993). Two species of parasitoids are largely responsible for reducing alfalfa weevil populations below damaging levels, *Microctonus aethiopoides*, which attacks alfalfa weevil adults, and *Bathyplectes anurus*, which attacks the larval stage (Radcliffe and Flanders 1998). In addition, the entomopathogenic fungus, *Zoophthora phytonomi*, kills a number of alfalfa weevils when environmental conditions are suitable (Harcourt et al. 1990). In Virginia, however, the alfalfa weevil persists as a major pest, despite numerous parasitoid releases (Bryan et al. 1993) and the occurrence of the fungus (Los and Allen 1983). Based on a three-year survey of 187 fields, I determined that alfalfa weevil exceeds the economic threshold in approximately one half of the state's alfalfa acreage each year (Chapter 2).

Pest pressure varies with geography in the state. In the Piedmont region, east of the Appalachian Mountains, milder winter temperatures result in a higher rate of alfalfa weevil oviposition and egg development compared with the ridge and valley regions in the western portion of the state (Chapter 3). As a result, greater infestations of larvae attack alfalfa earlier in the spring in the Piedmont. Consequently, the risk of alfalfa weevil damage is much greater in the Piedmont relative to the ridge and valley regions.

Ecological differences occur between Virginia and more northerly states (above 40 degrees latitude), which greatly impact alfalfa weevil biology. In the northern states, relatively few alfalfa weevil eggs are laid during the fall and winter months (Armbrust et al. 1966, Casagrande and Stehr 1973). Also, most eggs that are laid during this period do not survive the harsh winter (Townsend and Yendol 1968, Blickenstaff et al. 1972). Consequently, alfalfa weevil larval populations result primarily from eggs that are deposited in the spring. Spring oviposition,

albeit, is greatly reduced by *M. aethiopoides*, which parasitizes and sterilizes adult weevils. Alfalfa weevil oviposition is reduced up to 47% when *M. aethiopoides* is present in fields (van Driesche and Gyrisco 1979). Further, at least half of the alfalfa weevils that do make it to the larval stage are killed by natural enemies, primarily *B. anurus* and *Z. phytonomi*. This combination of harsh winter temperatures and biological control keeps alfalfa weevil populations in check in the northeastern U.S.

My research showed that in Virginia, alfalfa weevils deposit their eggs primarily in late-fall and early winter (Chapter 4). A high percentage of these eggs survive the mild winters to contribute to spring larval populations (Chapter 3). This difference in seasonal biology increases the damage potential of alfalfa weevil in Virginia because larvae emerge earlier in the spring and attack alfalfa at a shorter growth stage.

The host-parasitoid phenology of *M. aethiopoides* with alfalfa weevil also is disrupted by this difference in seasonal biology (Chapter 4). By the time 1st generation *M. aethiopoides* adults become active in the spring, most adult alfalfa weevils have laid their eggs and died. Consequently, adult parasitization is low and the contribution of this parasitoid to reducing alfalfa weevil numbers is negligible in Virginia.

The phenology of the larval parasitoid, *B. anurus*, with alfalfa weevil does not appear to be impacted by the warmer winter climate in Virginia (Chapter 4). Alfalfa weevil larval parasitization rates were comparable, if not higher than those reported in more northerly states. Nonetheless, successful biological control of alfalfa weevil requires both *B. anurus* and *M. aethiopoides* working in tandem (Day 1981, Kingsley et al. 1993). The latter may not be effective in warmer winter climates. Other southern states have reported low establishment and parasitization by *M. aethiopoides*, including Tennessee (Copley and Grant 1998) and Oklahoma (R. C. Berberet, *personal communication*).

An alternative to adult parasitism, cultural control techniques can be used to decrease alfalfa weevil egg populations. Late-fall harvesting and winter grazing remove the fall regrowth of

alfalfa and leave only short stubble to overwinter (Hilburn 1985). These management techniques physically remove alfalfa weevil eggs that have been laid, limit suitable oviposition sites, and expose adults and eggs to more extreme temperatures. These practices have shown success in Oklahoma (Senst and Berberet 1980, Dowdy et al. 1992). Late-fall harvesting or winter grazing coupled with larval parasitization may be an effective integrated pest management approach that could potentially bring alfalfa weevil populations in check in many areas of Virginia, and reduce the need for insecticide applications. More research is needed, however, to determine the detrimental effects of fall regrowth management on the alfalfa plant.

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Thomas Patrick Kuhar

Thomas P. Kuhar was born in Baltimore, Maryland on March 29, 1969. In 1987 he began his undergraduate studies in biology at Towson University (TU), Towson, Maryland. While at TU, his interests shifted from medicine to ecology and animal behavior. He was particularly inspired to study entomology after taking a course offered by Dr. Aubrey G. Scarbrough. In his senior year at TU, Tom assisted Dr. Scarbrough with his systematic research on robber flies (Diptera: Asilidae) and co-authored two journal articles. He was honored by the TU Biology Department with the James Moniodis Scholarship and the Lois D. Odell Award for outstanding biology student, and received his Bachelor of Science in May of 1992. Two days following graduation, he moved to Blacksburg, Virginia and began his Master's work in the Department of Entomology at Virginia Polytechnic Institute and State University (VPI & SU). Under the direction of Dr. Roger R. Youngman, he investigated the pest management of western corn rootworm. While pursuing his Master's degree at VPI & SU, he served as President of the W. B. Alwood Entomological Society, Chairman of the Graduate Student Committee of the Entomological Society of America, and received the Dow Elanco Entomology Award in 1993, the James McD. Grayson Scholarship in 1994, and the Michael Kozstarab Systematics Award in 1995. Tom was awarded a University Cunningham Doctoral Research Fellowship in 1995 to continue his studies at VPI & SU.

From 1996 to 1999, Tom researched the ecology of alfalfa weevil in Virginia, again under the direction of Dr. Youngman. He received two University Graduate Research Development Grants, and was the recipient of the Virginia Crop Production Association Graduate Scholarship and the James McD. Grayson Award for Ph.D. student in 1998. On August 28, 1999, Tom married Stacey Ann Brousseau. Tom defended his Ph.D. on February 8, 2000. He started a research associate position at Cornell University two weeks after his defense.