LYGUS MANAGEMENT: A WESTERN PERSPECTIVE

Peter Ellsworth
University of Arizona
Maricopa, AZ

Lygus hesperus Knight (Hemiptera: Miridae) has been a consistent target for Arizona cotton producers for a very long time; however, its status as number one pest over the last 10 years is largely due to the major gains in other control systems (Bt cotton for lepidopteran control & selective insecticides including IGRs for the control of *Bemisia* whiteflies) (Fournier et al. 2007). The last two seasons (2006 & 2007) set record lows in foliar insecticide use in Arizona cotton. Despite this, Lygus bug remains our most important pest, even when averaging less than 1.4 sprays applied against all pests (see Williams et al. 2008). Additional focus on this pest is warranted, because of our historical dependence on very old, very broad-spectrum chemistry (endosulfan since 1959; acephate since 1973; and oxamyl since 1974). The consequences of over-reliance on broad-spectrum insecticide usage are well-known—elimination of key natural enemies, secondary pest outbreaks, pest resurgence, and resistance.

While there are no "silver bullets" on the horizon, we view many opportunities, both "great" and "small" for making incremental, but progressive improvements to our management system. Abundance of any insect is controlled largely by movement, a set of broad-scale features, and local management. Local management is defined by three keys: sampling, effective chemical use and avoidance. Effective local management practiced widely should contribute to an overall lowering of pest densities regionally. So practices such as efficient sampling (100 sweeps per management unit), better implementation of thresholds (15 total Lygus with 4 nymphs per 100 sweeps), and use of non-disruptive, yet effective, compounds (e.g., Carbine® or flonicamid) are some of the "small" improvements that can be made. The concomitant challenge to producers and consultants is to be able to identify what and how natural enemies are contributing to field-specific control of Lygus and other pests. Furthermore, with development of new chemistries with unfamiliar properties (e.g., slow-acting, behavior modifying, or sublethal), consultants will need to be the eyes on the field in order to determine if Lygus are feeding or causing damage and when or if Lygus bugs are dying.

The lesson taught by the oppressive swarms of *Bemisia* whiteflies in the early 1990's was that "local management" was not enough when faced with a mobile, polyphagous pest. In addition to efficient local management across all commodities, some level of cooperation and communication was needed to mitigate large movements across the landscape. Like *Bemisia*, Lygus bugs are mobile and polyphagous with the capacity to exploit dozens of crop and non-crop habitats. Also like *Bemisia*, not all crops are managed for the presence of Lygus and therefore some habitats serve as "sources" and some as "sinks" for Lygus populations. The distributions of these sources and sinks over the farmscape or larger regions represent the landscape factors that control Lygus densities generally.

Can we learn enough about the distributions of hosts and capacity for movement of Lygus to exploit these landscape factors for our productive and economic benefit? This is the "great" challenge and opportunity we have for advancing pest management in the 21st century. Producers have known for decades that adjacent crops affect distributions and severity of pest infestations; e.g., seed alfalfa or safflower sources Lygus to adjacent cotton or other sensitive crops. Other relationships and their range of influence are unknown, even as our crop diversity changes throughout the West due to land use changes and market pressures (e.g., introduction of new and "old" crops as potential biofuels; guayule for latex production; and ex-urbanization).

Through a large collaboration fueled by a USDA-CSREES Risk Avoidance & Mitigation Program (RAMP) grant, 13 western scientists from TX, NM, AZ and CA are developing both local and landscape-level technologies for better management of Lygus throughout the western agro-ecosystem. Over 32 subprojects are involved ranging from studies of new chemistries for control of Lygus in various crops to large surveys of Lygus in western agricultural communities. The balance of this paper will briefly outline this latter effort, which constitutes one of our "great" opportunities for understanding and improving management of Lygus on a large scale (e.g., from farmscape to areawide).

Teams of researchers in CA (led by Pete Goodell, UC-IPM), TX (led by Megha Parajulee, Texas A&M) and AZ (led by Peter Ellsworth, UA) are in the first year of a 3-yr project to describe and understand Lygus distributions as a function of crop and non-crop habitat density and diversity over large regions. In each locale, the central valley of

CA, west TX, and central AZ, about 50 focal cotton fields were identified for the routine, weekly sampling of Lygus (and natural enemies) during the summer of 2007. Four samples totaling 100 sweeps per field were taken during the flowering period and frozen for later processing. In addition, other sample habitats typical of the region (e.g., alfalfa, weeds, guayule) were also surveyed for Lygus. The combined land mass of the 3 regions in this study totaled over 1 million acres.

In each locale, the entire crop and non-crop habitat was identified and mapped for a radius of 3km around each focal field. Using GIS tools, we can examine the specific arrangement (distances from the focal field) and density (acreage) of each habitat in successive slices or rings around the focal field (e.g., at 0.75km increments) (see Carrière et al. 2006). The CA locale represents an area of great agricultural diversity but with very low topographic complexity or natural habitat distribution. Agricultural fields are very large there and little vegetation exists outside the boundaries of irrigated fields. The TX locale represents relatively low agricultural diversity (e.g., mainly cotton and sorghum) and low topographic complexity. Native habitat is normally also low in diversity, except West Texas received record levels of spring rainfall that resulted in decades-high extra-field and roadside vegetative habitat. The AZ locale represents medium agricultural diversity (e.g., cotton, small grains, alfalfa, melons, guayule, corn) and high topographic complexity (e.g., washes, drainages, buttes, mountains). Rainfall was low there, so desert habitat was relatively depauperate in vegetation.

Within each locale, there are many different scenarios, representing the continuum of risk of Lygus infestation. For example, some habitats around focal cotton fields are dominated by alfalfa production, or are low in crop diversity or cropping intensity. Other areas are associated with abandoned, fallowed, desert, or actively growing weedy habitats. Still others are influenced by novel associations (e.g., guayule production) or relatively new cropping patterns for an area (e.g., corn, sweet sorghum, or other forage / biofuel crops). By examining Lygus densities in the focal fields and relating these to densities of different habitats in each successive ring, we can geostatistically correlate the rise and fall of bug densities with specific arrangements and distances of surrounding habitat. When the correlation is strong and significant, there is a relationship we might be able to exploit for management purposes through crop placement, arrangement or with other strategic planting decisions. In essence, we can identify both sources and sinks for Lygus within various landscapes and determine what scenarios are "risky" as far as potential for Lygus infestation.

To summarize, our challenge is to manage for areawide impact. By lowering the suitability of the ecosystem for sustaining economic populations of a pest, we can practice the ultimate in "avoidance". Our basic formula is: Pest Abundance is the product of local, field-scale management and broader scale factors. So there are opportunities to practice better field-scale management by deploying reduced-risk, more selective chemistries when needed and as determined by careful sampling, and better implementation of dynamic thresholds that incorporate or consider the benefits of natural enemies. These are our "small", field-level, opportunities. Our farmscape decisions will some day be enhanced by new information that will enable better crop placement that lowers Lygus risks community-wide. This is our "great" opportunity.

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The Arizona Pest Management Center (APMC) as part of its function maintains a website, the Arizona Crop Information Site (ACIS) (*http://cals.arizona.edu/crops*), which houses all crop production and protection

information for our low desert crops, including a PDF version of the presentation of this paper for those interested in reviewing its content:
http://ag.arizona.edu/crops/presentations/08Nashville_Western_Lygus_vFlo.pdf.

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