Chapter 15
Genomics of Insect-Soybean Interactions

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Introduction

On-going efforts to lower costs of production, along with increased concerns over insecticide residues in the food chain and in the environment are incentives to conduct research on crop resistance to insect pests. While multiple genes for resistance to insects have been identified in many plants (Yencho et al. 2000), understanding their molecular basis remains far behind the understanding achieved for disease resistance genes. Given that plants and insects have co-evolved for millions of years, it is not surprising that a wide range of plant-insect relationships exist and that many of these have a very different genetic basis. The following review is an attempt to categorize the various plant-host relationships that exist within soybean and provide a summary of what is known about the genetics of resistance and its characterization at the genomic level.

Damage Caused by Soybean Insect Pests

Insect pests of soybean are well recognized, though their economic impact is hard to quantify, as data on insect damage are seldom collected. Georgia is perhaps the only state that historically has kept data on insect damage to the various crops grown in the state. In 2004, the last year for which data are available, there were 72,800 ha planted in soybean, for a crop valued at $43.1 million. During 2004,

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1 Abbreviations of commonly cited insect names
BAW = beet armyworm, Spodoptera exigua Hübner; BLB = bean leaf beetle, Cerotoma trifurcata Forster; CEW = corn earworm, Helicoverpa zea Boddie; LCB = Lesser cornstalk borer, Elasmopalpus lignosellus Zeller; MBB = Mexican bean beetle, Epilachna varivestis Mulsant; PLH = potato leafhopper, Empoasca fabae Harris; SBA = soybean aphid, Aphis glycines Matsumura; SBL = soybean looper Pseudoplusia includens Walker; TBW = tobacco budworm, Heliothis virescens Fabricius; VBC = velvetbean caterpillar, Anticarsia gemmatalis Hübner
Georgia soybean farmers spent $3.3 million on insect control and lost an additional $4.25 million due to insect-induced yield reduction. Thus the combined cost of insect control and yield loss was equal to 17.5% of total crop value in 2005 (McPherson 2004).

Insect-caused injury to soybean depends on the feeding behavior and biology of the pest, the potential of the pest to vector pathogens and, in some cases, on the development stage of the plant. The majority of the principal soybean insect pests can be classified on the basis of their feeding technique into piercing-sucking, chewing, or tunneling pest species. Chewing insects can damage foliage, reproductive organs, and/or stems.

**Piercing-Sucking Insects**

The major pests in this category are in the order Hemiptera, which now includes the true bugs, such as stink bugs, and the aphids (suborder Sternorrhyncha) and leafhoppers (suborder Auchenorrhyncha). The green (*Acrosternum hilare* Say), southern green (*Nezara viridula* L.) and brown (*Euschistus servus* Say) stink bugs comprise the bulk of the soybean stink bug complex in North America. The primary economic damage in soybean results when nymphs and adults pierce pods and developing seeds to feed on plant juices. Damage to young pods can cause shriveled seed and pod abortion, while feeding on developing seed can result in abnormal development, wrinkling, and a stained seed coat (Turnipseed and Kogan 1987). Stink bugs are polyphagous, so they can easily move into soybean fields from alternative hosts such as cotton. Economic damage from stink bugs can outweigh damage from all other insects in the South (McPherson 2004).

The soybean aphid (*Aphis glycines* Matsumura) was first reported in the United States in 2000, and has rapidly become a major insect pest in the Midwest (Hill et al. 2004). Aphid feeding can result in yield loss, severe stunting, leaf distortion, reduced pod set, lower seed weight, and nutrient deficiencies (Mensah et al. 2005). Indirect damage is caused by transmission of viruses like soybean mosaic virus, alfalfa mosaic virus, soybean dwarf virus, and bean yellow mosaic virus (Hill et al. 2001). Growth of sooty mold on ‘honeydew,’ a sticky substance excreted by feeding aphids, can further reduce photosynthesis and yield (Mensah et al. 2005). Feeding by other hemipteran pests such as the potato leafhopper (*Empoasca fabae* (Harris)) and the three-cornered alfalfa hopper (*Spissistilus festinus* (Say)) can cause damage to leaves or make weakened stems more prone to lodging (Turnipseed and Kogan 1987).

**Chewing Insects**

These include lepidopteran and coleopteran larvae and adults that feed on soybean leaves and seed pods. Major lepidopteran pests include the green cloverworm