Review and Current Status of *Systena frontalis* (Coleoptera: Chrysomelidae): An Insect Pest Associated with Nursery Production Systems[1]

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Abstract *Systena frontalis* (F.) (Coleoptera: Chrysomelidae) is an insect pest of nursery production systems throughout the Midwest, Southeast, and Northeast regions of the United States. The original scientific name was *Galleruca frontalis* F. before reclassification of the genus to *Systena*. There is minimal information in the scientific literature providing evidence that *S. frontalis* is native or an introduced species. In addition, the overwintering life stage is unknown. However, records indicate that *S. frontalis* is native to North America based on reports of this beetle being found in 5 provinces of Canada and 31 states in the United States. Records also indicate that the adult may be the overwintering life stage. Current management strategies implemented to reduce feeding damage caused by *S. frontalis* adults to container-grown nursery plants are associated with foliar spray applications of contact insecticides. However, applying contact insecticides to plant material in nursery production systems is labor intensive and not cost efficient. Application of systemic insecticides to the growing medium is a management strategy that nursery producers can use to reduce feeding damage caused by *S. frontalis* adults. Research demonstrates that the systemic insecticides dinotefuran and thiamethoxam protect container-grown nursery plants 45 d after application. Therefore, based on empirical, scientific-based research, applying systemic insecticides before *S. frontalis* adults are active provides practical and cost-effective plant protection from adult feeding damage during the growing season, thereby allowing nursery producers to grow, market, and sell container-grown nursery plants.

Key Words taxonomy, biology, *Galleruca frontalis*, management, systemic insecticides

Systena frontalis (F.) (Coleoptera: Chrysomelidae) is an insect pest of nursery production systems throughout the Midwest, Northeast, and Southeast regions of the United States. Feeding damage caused by *S. frontalis* adults can result in losses of nearly US$500,000, or 11% of plant material sales per year for a single nursery production operation (Herrick and Cloyd 2020). Minimal information is available, especially from the scientific literature, associated with *S. frontalis*. In this review, we discuss the history and taxonomy, biology and feeding behavior, and the current management strategies used in nursery production systems to protect container-grown nursery plants from *S. frontalis* adult feeding damage.

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History and Taxonomy

Adult specimens of *S. frontalis* were obtained in 1801 from Carolina (now, South Carolina) in the United States (Blake 1952). Johann C. Fabricius (7 January 1745–3 March 1808) originally classified the insect as *Galleruca frontalis* (Blake 1952, Bousquet and Bochard 2013, Zimsen 1964). In 1836, Louis A. A. Chevrolat (29 March 1799–16 December 1884) reclassified the genus by using the type specimen originally obtained and classified by Johann C. Fabricius as *G. frontalis* to the genus *Systena* (Bousquet and Bouchard 2013). Hence, this beetle is currently known under the scientific name *Systena frontalis* (F.) (Bousquet and Bouchard 2013). There is no documentation associated with any scientific-based research on *G. frontalis* between 1801 and 1836, which was before the currently accepted classification of this beetle as *S. frontalis*.

Herrick and Cloyd (2020) suggested that *S. frontalis* might not be native to the United States because there was no taxonomic documentation affiliated with the earliest scientific study on the insect (Peters and Barton 1969). However, after an extensive review of the literature, evidence indicates that *S. frontalis* was originally recorded in the United States from South Carolina in 1801 (Zimsen 1964). *Systena frontalis* was then recorded in Ontario, Canada, in 1861 (Beadle 1861) and Lawrence, KS, in the United States between 1879 and 1880 (Snow 1881). Since these early records, *S. frontalis* has been reported in 5 provinces of Canada and in 31 states in the United States, indicating that *S. frontalis* is native north of Mexico because there are no other records of the insect except those from the West Indies (Riley et al. 2003).

Biology and Feeding Behavior

Biology. The life cycle of *S. frontalis* includes egg, larva, pupa, and adult life stages. Eggs are 0.7–0.8 mm in length and pale yellow (Jacques and Peters 1971). Larvae are approximately 8 mm long and creamy white, with a brown head capsule, and small protruding legs (Jacques 1987, Peters and Barton 1969). There are three larval instars (Peters and Barton 1969) that are found in the growing medium or soil (Jacques and Peters 1971). Larvae feed on plant roots (Jacques and Peters 1971), but the extent of larval feeding damage related to plant health is unknown (Jacques and Peters 1971, Peters and Barton 1969). The pupal stages (prepupa and pupa) are located in the growing medium or soil (Jacques 1987). Adults are 4–5 mm in length and shiny black with a distinct red head (Saunders 1883). Adult females are typically larger than males. Adults have enlarged hind femora that allow them to jump like a flea (Saunders 1883), hence the common references as “red-headed flea beetle” (Peters and Barton 1969). The jumping behavior of adults allows them to avoid exposure from insecticide spray applications, which can affect the ability of insecticides to manage adult populations in nursery production systems below plant-damaging levels (Herrick and Cloyd 2020).

Herrick and Cloyd (2020) found that *S. frontalis* can overwinter in the growing medium of container-grown nursery plants. However, the specific overwintering life stage of *S. frontalis* is unknown. Although there are claims that *S. frontalis* overwinters as an egg (Jaffe et al. 2021, Kunkel 2016, Lauderdale 2017), none of these claims are conclusive or supported by empirical scientific studies. In actuality, records indicate that the adult could be the overwintering life stage (Blatchley 1896, 1910; Crosby and Leonard 1918). For example, *S. frontalis* adults have been found overwintering under the bark of silver maple (or white maple), *Acer dasycarpum* Ehrhart (now *Acer saccharinum* L.) trees and on the leaves and in the rosettes of mullein, *Verbascum* spp., plants (Blatchley 1910, Crosby and Leonard 1918).

Feeding behavior. Adult *S. frontalis* feed on >50 plant species in >35 plant families (Clark et al. 2004), including different weed species, such as smartweed, *Polygonum* spp.; lambsquarters, *Chenopodium album* L.; great ragweed, *Ambrosia trifida* L.; and pigweed, *Amaranthus* spp. (Blatchley 1896, Crosby and Leonard 1918, Jacques and Peters 1971). Adults feed on the leaves of a wide range of ornamental plants grown in nursery production systems. Container-grown nursery plants susceptible to feeding by *S. frontalis* adults include *Callicarpa* spp., *Cornus* spp., *Forsythia* spp., *Hydrangea* spp., *Itea* spp., *Physocarpus* spp., *Sedum* spp., and *Weigela* spp. (Herrick and Cloyd 2020; A. Rios, Loma Vista Nursery; Ottawa, KS, pers. comm.).

Leaf or foliar damage caused by *S. frontalis* adult feeding reduces aesthetic plant quality and subsequent salability of plants (Herrick and Cloyd 2020). Adults feed on the top and bottom of the leaf surface (Saunders 1883), resulting in necrotic leaf spotting and/or holes in leaves (N.J.H. and R.A.C., pers. obs.). The newer leaves appear to be preferred over the older leaves (Jacques 1987). In addition, adults can leave black fecal deposits on leaves that have been fed upon (Cloyd and Herrick 2018), impacting the aesthetic value of the plant. The extent of feeding damage varies depending on the plant species on which the adults feed. However, adults appear to exhibit no preference among plant species grown in nursery production systems (Herrick and Cloyd 2020).

Management Strategies

Presently, there are no effective, cost-efficient cultural or biological control management strategies for use against *S. frontalis* adults in nursery production systems. Historically, recommendations for managing *S. frontalis* adult populations included foliar applications of contact insecticides, such as Paris green (copper arsenite) and London purple (calcium arsenate) (Riley and Howard 1892). Presently, foliar applications of contact insecticides are the primary means of protecting container-grown nursery plants from *S. frontalis* adult feeding damage. However, foliar applications of contact insecticides do not provide sufficient adult mortality because adults can migrate to blocks of container-grown nursery plants not treated with a contact insecticide. In addition, container-grown nursery plants may not all be treated in a single day or treated again with a contact insecticide for several days or weeks after an initial application (T. Minter, Loma Vista Nursery, pers. comm.). Adults of *S. frontalis* are also able to avoid exposure from insecticide spray applications by jumping off plants or falling onto the surface of the growing medium (Herrick and Cloyd 2020).

Contact insecticides must be applied weekly when adults are active during the growing season. However, weekly foliar applications of contact insecticides are labor intensive and cost prohibitive for large nursery operations (Herrick and Cloyd 2020). For example, the total labor hours required to apply contact insecticides can be as much as 160 h/yr for a single nursery production operation (T. Minter, Loma Vista Nursery, pers. comm.). Thorough coverage of the top and bottom of plant leaves is important to protect plants from *S. frontalis* adult feeding damage (Martini et al. 2012, Tipping et al. 2003). In addition to obtaining thorough coverage of plant leaves, applications of contact insecticides must be directed at the growing medium because adults will fall onto the growing medium surface or leave plants when disturbed (Herrick and Cloyd 2020). Weekly applications of contact insecticides are labor intensive and not time or cost efficient for large nursery operations (Herrick and Cloyd 2020). Consequently, another management strategy is needed to protect container-grown nursery plants from *S. frontalis* adult feeding damage.

Systemic insecticides are applied to the growing medium where they are absorbed by plant roots and translocated through the plant vascular system (xylem and phloem) into leaves where insects feed (Bennett 1949, Poe and Marousky 1971). Insects are killed after ingestion of lethal concentrations of the systemic insecticide active ingredient or metabolites during feeding (Ahmed et al. 1954, Reynolds 1954). Systemic insecticides may protect plants from insect feeding damage for up to 10 wk during the growing season (Schuster and Morris 2002), which would reduce costs associated with insecticide spray applications (Cloyd et al. 2011, Jeppson 1953, Reynolds 1954). In addition, systemic insecticides would likely kill the larval stages of the *S. frontalis*, thereby reducing the number of adults emerging from the growing medium (Cloyd and Herrick 2023).

Cloyd and Herrick (2023) demonstrated, based on laboratory and greenhouse experiments, that when applied to the growing medium, systemic insecticides can protect container-grown nursery plants for extended time periods. Recently, Herrick and Cloyd (2024) found that one application of the systemic insecticides dinotefuran (Safari®, Valent USA, Corp., Walnut Creek, CA) and thiamethoxam (Flagship®, Syngenta Crop Protection, LLC; Greensboro, NC) protected *Itea virginica* L. 'Little Henry' plants from *S. frontalis* adult feeding for 45 d after application. Hence, systemic insecticides can lessen the feeding damage to container-grown nursery plants caused by *S. frontalis* adults.

Conclusion

Nursery producers require practical and cost-effective management strategies to reduce plant damage caused by *S. frontalis* adults. Based on empirical, scientific-based research, using systemic insecticides may be the most practical and cost-effective management strategy that provides protection from feeding damage caused by *S. frontalis* adults and allow nursery producers to grow, market, and sell container-grown nursery plants.

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