Impact of Host Plant Resistance on Emergence, Body Parameters, and Supercooling Point of Cylas formicarius elegantulus (Coleoptera: Brentidae)

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Abstract

Sweetpotato weevil, *Cylas formicarius elegantulus* (Summers) (Coleoptera: Brentidae), an in-field and storage pest of sweetpotato, is the primary insect constraint to sweetpotato production in tropical and subtropical regions. Feeding by adult and larval sweetpotato weevil induces terpenes, rendering storage roots unmarketable. To reduce storage root damage and sweetpotato weevil populations, the present experiment tested the impact of sweetpotato cultivar on developmental time, adult emergence, body length, weight, and supercooling point of sweetpotato weevil. The cultivars tested were 'Beauregard' and 'Evangeline,' both orange fleshed cultivars susceptible to sweetpotato weevil, and 'Murasaki,' a white fleshed cultivar known to be resistant to sweetpotato weevil. There were no differences in developmental time with most adult sweetpotato weevils emerging 34 to 44 d after oviposition. However, the number of adult sweetpotato weevil that emerged from Beauregard (38.9 ± 3.3) and Evangeline (48.4 ± 6.2) roots were greater than numbers emerging from Murasaki (11.1 ± 3.5), indicating resistance is due to antixenosis. Although fewer in number, adults (male and female) emerging from Murasaki were heavier than males and females emerging from Beauregard and males from Evangeline. Supercooling points of sweetpotato weevil males emerging from Murasaki (−17.9 ± 0.4 °C) were significantly lower than Beauregard (−16.3 ± 0.5 °C) but similar to Evangeline (−17.1 ± 0.4 °C). Host plant resistance expressed by Murasaki may reduce sweetpotato weevil populations significantly, but those that emerge may be better suited to survive the cold.

Key Words: sweetpotato weevil; *Ipomoea batatas*; antixenosis; insect morphology; cold hardiness; resistant host cultivar

Resumen

El gorgojo de la batata (el picudo del camote), *Cylas formicarius elegantulus* (Summers) (Coleoptera: Brentidae), una plaga de campo y de almacenamiento de la batata, es el insecto principal que limita la producción de batata en las regiones tropicales y subtropicales. La alimentación de adultos y larvas del gorgojo de la batata induce terpenos, lo que hace que las raíces de almacenamiento no sean comercializables. Para reducir el daño de las raíces de almacenamiento y las poblaciones del gorgojo de la batata, el presente experimento evaluó el impacto de los cultivares de batata sobre el tiempo de desarrollo, la emergencia de adultos, la longitud corporal, el peso y el punto de sobre-enfriamiento del gorgojo de la batata. Los cultivares probados fueron "Beauregard" y "Evangeline," ambos cultivares de pulpa anaranjada susceptibles al gorgojo de la batata, y "Murasaki," que es considerada un cultivar de pulpa blanca resistente al gorgojo de la batata. No hubo diferencias en el tiempo de desarrollo con la mayoría de los gorgojos adultos emergiendo de 34 a 44 días después de la oviposición. Sin embargo, el número de adultos del gorgojo de la batata que emergió de las raíces de Beauregard (38,9 ± 3,3) y Evangeline (48,4 ± 6,2) fue mayor que el número que emergió de Murasaki (11,1 ± 3,5), lo que indica que la resistencia se debe a la antixenosis. Aunque menos en número, los adultos (machos y hembras) que emergen de Murasaki eran más pesados que los machos y hembras que emergen de Beauregard y los machos de Evangeline. Los puntos de sobre-enfriamiento de los machos del gorgojo de la batata que emergen de Murasaki (−17,9 ± 0,4 °C) fueron significativamente más bajos que los de Beauregard (−16,3 ± 0,5 °C) pero similares a los de Evangeline (−17,1 ± 0,4 °C). La resistencia de la planta hospedera expresada por Murasaki puede reducir significativamente las poblaciones del gorgojo de la batata, pero las que emergen pueden ser más adecuadas para sobrevivir al frío.

Palabras Clave: gorgojo de la batata; *Ipomoea batatas*; antixenosis; morfología de insectos; resistencia al frío; cultivar huésped resistente

Sweetpotato (*Ipomoea batatas* [L.] Poir; Convolvulaceae) is the third most important root crop following potato (*Solanum tuberosum* L.; Solanaceae) and cassava (*Manihot esculenta* Crantz; Euphorbiaceae), and is ranked the sixth most valuable food crop in the world (Loebenstein 2015; Low et al. 2015; International Potato Center 2018). Sweetpotatoes are grown worldwide in 117 countries comprising an area of 8.62 million ha, with an annual production of 105.19 million tons (FAO 2016). Besides being a source of income and food security in resource-poor countries, the production and consumption of sweetpotato in the US has increased considerably since 2000 (USDA 2016).

In 2015, the value of this specialty crop was estimated at more than USD $700 million. Sweetpotato is the most important vegetable crop in Louisiana, USA. The 2,711 ha (6,700 acres) planted in Louisiana in 2020 had a total value of USD $95 million (Morgan, 2021).

Sweetpotato is attacked by a wide array of insect pests, ranging from root feeders to leaf miners (Chalfant et al. 1990). Of those, sweetpotato weevil, *Cylas formicarius elegantulus* (Summers) (Coleoptera: Brentidae), is the most destructive pest, being a major constraint to sweetpotato production (Chalfant et al. 1990; Hue & Low 2015). Adult weevils feed on all parts of the sweetpotato plant; however, most of

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the damage comes from larval feeding and tunneling, rendering the roots unconsumable. Even a low-level infestation can cause considerable damage by triggering sesquiterpene production that makes sweetpotatoes bitter in taste (Chalfant et al. 1990; Sorensen 2009; Korada et al. 2010). In countries where sweetpotato is grown for both consumption and income, sweetpotato weevil infestations can become a food security issue. Thus, the success of the sweetpotato industry is dependent on the development of high yielding, high quality, pest-resistant cultivars.

To combat sweetpotato weevil, the development of insect resistant sweetpotato lines has been seen as a priority for sweetpotato weevil-integrated pest management. Breeders have aimed to create high yielding, marketable cultivars with resistance to sweetpotato weevil. Though several heirloom and traditional cultivars ('Charleston Scarlett,' 'Regal,' 'Resisto,' 'Ruddy,' and 'Sumor') have been screened and developed for resistance, they have not found grower acceptance (Jackson & Harrison 2013). Commonly grown orange-fleshed sweetpotatoes like *I. batatas* cv. 'Beauregard,' one of the leading commercial sweetpotato cultivars, and *I. batatas* cv. 'Evangeline,' resistant to southern root-knot nematode, *Meloidogyne incognita* (Kofoid & White) (Tylenchida: Heteroderidae) (Chitwood 1949) race 3, are highly susceptible to sweetpotato weevil (Jackson & Harrison 2013; Chen et al. 2019). *Ipomoea batatas* cv. 'Murasaki', a white fleshed cultivar which does meet grower acceptance and is in high demand in Asian markets, displays resistance to the *Diabrotica* and *Systena* complex, sweetpotato flea beetle (*Chaetocnema confinis* Crotch; [Coleoptera: Chrysomelidae]), white grub larvae (*Plectris aliena* Chapin and *Phyllophaga* Harris spp. [both Coleoptera: Scarabaeidae]) and sweetpotato weevil (La Bonte et al. 2008b; Jackson 2010; Jackson & Harrison 2013; Chen et al. 2019).

Host plant resistance is the sum of heritable characteristics of a species or cultivar that enable it to avoid, resist, tolerate, or recover from insect attack (Snelling 1941; Painter 1958). Antixenosis and antibiosis are 2 major categories of host plant resistance in which the former results in reduced preference for the host plant, and the latter directly interferes with insect growth, development, and physiology (Smith 2005). Antixenosis often is caused by physical barriers, chemical feeding, or oviposition deterrent, whereas antibiosis depends on the nutritional quality of the host (Smith 2005). In nature, these 2 mechanisms often are present together in a host and can simultaneously affect an insect's life history by influencing morphological parameters, developmental time, and emergence success.

As mentioned earlier, Murasaki already is recognized as a resistant cultivar, but it is not clear how it affects sweetpotato weevil compared to susceptible cultivars such as Beauregard and Evangeline. Many, if not most, studies of the effects of resistant plant cultivars on insect herbivores focus on the growth and survival of insects, but the resistance-related properties of a host plant can affect a diversity of life cycle parameters including body size, overwintering success, fecundity, susceptibility to diseases, and overall fitness (Morrill et al. 1994; Sequiera & Dixon 1996; Awmack & Leather 2002; Kariyat & Portman 2016). For female insects, body size is correlated positively with the number of offspring produced and often is described as a principal constraint in potential fecundity (Lawrence 1990; Honěk 1993; Choe & Crespi 1997). In the case of males, it is an important indicator of fitness, predicting mating success (Honěk 1993; Beukeboom 2018). Therefore, by affecting sweetpotato weevil male-female body parameters, host plant resistance may influence the population size of subsequent generations (Honěk 1993; Sequiera & Dixon 1996; Awmack & Leather 2002).

Insect morphology, especially body size and weight, also play a crucial role in tolerating lower temperatures (Zvereva 2002; Hou et al. 2009; Maes et al. 2012). Studies on the darkling beetle, *Alphitobius dia-*

perinus Panzer (Coleptera: Tenebrionidae), showed a significant positive correlation between body mass and survival when beetles were exposed to cooler temperatures (Renault et al. 2003). For ectotherms like insects, the typical way to tolerate cold is to lower the temperature of the body fluid below freezing, which is known as supercooling (Bale 1987; Hanson & Graig 1995). Host plant nutritional properties often influence the supercooling point by altering cryoprotectant synthesis (Maes et al. 2012; Littler et al. 2021). Thus, host plant resistance has the potential to alter winter survival, thereby affecting population sizes over multiple yr.

Host plant resistance can lessen pest pressure effectively by increasing developmental duration and reducing fecundity, thus favoring population regulation by natural enemies (Snelling 1941; Honěk 1993; Smith 2005). Commercial sweetpotato production relies heavily on pesticide use which effectively eliminates predators and can flare insecticide-resistant populations. Host plant resistance has an advantage over biological control in that it is entirely compatible with insecticide use. Insect resistance found in cultivars, in combination with biological control or reduced insecticide use, should provide substantial control, reducing reliance on pesticides and saving growers money. Therefore, the objectives of this study were to evaluate the impact of host plant resistance found in cv. Murasaki and compare its effects on sweetpotato weevil body parameters, adult emergence, and supercooling point with 2 susceptible cultivars under controlled laboratory conditions prior to large-scale field evaluations.

Materials and Methods

SWEETPOTATO WEEVIL COLONY

A colony of sweetpotato weevil was initiated using weevils collected from sweetpotato fields in southwest Louisiana in 2013 (Chen et al. 2019). This colony was maintained on sweetpotato cultivar Beauregard storage roots as per Chen et al. (2019).

STORAGE ROOTS

Sweetpotato storage roots of cvs. Beauregard, Evangeline, and Murasaki were provided by the Louisiana State University AgCenter Sweet Potato Research Station, Chase, Louisiana, USA. Cultivars were grown using standard grower practices (Smith et al. 2012) and roots were harvested, cured, and stored for 1 to 2 mo before use in experiments.

HOST PLANT RESISTANCE IMPACT ON SWEETPOTATO WEEVIL ADULT EMERGENCE

Studies were conducted to evaluate the impact of host plant resistance on total and daily emergence of adults from storage roots. For each experiment, individual roots were placed in 1-quart, cylindrical (8.57 cm diam) paper containers in a rearing room (0:24 h [L:D]; 27.0 ± 1 °C, 65.0 ± 5% RH) on shelves in a randomized complete block design. Six gravid female sweetpotato weevils were placed on each root in each container and allowed to oviposit for 4 d. Female sweetpotato weevils then were removed from the containers and returned to the colony. For total adult emergence trials, experiments were conducted over a 5 yr period (2011–2015) in which blocks were replicated for a total of 10 replications per cultivar per yr. Starting at 30 d after oviposition, containers were examined every other d for emerging adults. Emerging adults were counted and removed. Counts were made for a period of 4 wk and total number of adults emerging from each root was calculated.

For daily adult emergence trials, 4 separate experiments were conducted in 2013 in which blocks were replicated for a total of 10 replications per cultivar per experiment. Starting at 30 d after oviposition, containers were examined every d for emerging adults. Emerging adults were counted and removed. Counts were made for a period of 26 d.

HOST PLANT RESISTANCE IMPACT ON SWEETPOTATO WEEVIL ADULT MASS AND BODY SIZE

To determine the contribution of host cultivar to body length variation and mass, newly emerged adult weevils from different cultivars were measured. Separate colonies were created using each cultivar as a rearing host as per Chen et al. (2019), and experiments were conducted on the F1 generation. Five colonies of each cultivar were created using 2 to 3 storage roots per rearing container. At approximately 40 d after colony initiation, 20 adults (10 females and 10 males) were chosen randomly from each container, weighed, and measured. Insects were sexed using antennal differences as described by Starr et al. (1997). Total body length (tip of pronotum to the end of elytra) was measured using a microscope equipped with an eyepiece micrometer (MA524, 1 mm divided into 100 U for a minimum unit of 0.01 mm; Meiji Techno America, San Jose, California, USA). Weights (mg) were measured using a Mettler Toledo XS105 (Columbus, Ohio, USA).

HOST PLANT RESISTANCE IMPACT ON SWEETPOTATO WEEVIL SUPERCOOLING POINTS

Supercooling points for individual insects were measured through surface contact thermocouple thermometry as per Bastola and Davis (2018). Briefly, insects were placed in a 2 mL plastic tube (Nalgene, Thermo Scientific, Waltham, Massachusetts, USA) in a Nalgene Cryo 1 °C freezing container (Cat No. 5100-0001) after a type T thermocouple (copper/constantan 24 gauge Teflon wrap, 0.91 m long, Teflon-coated; DATAQ Instruments, Akron, Ohio, USA) was attached to the abdomen of each individual insect using high-vacuum grease (Dow Corning Corporation, Midland, Michigan, USA). The freezing container was filled with 250 mL of isopropanol and placed in a −20 °C freezer, allowing the insects to cool at the rate of 1 °C per min. Temperatures were logged every 0.5 s through a multichannel data logger (Model DI-1000TC-Y, DATAQ Instruments, Akron, Ohio, USA). Temperatures were recorded for 4 adult sweetpotato weevil in each trial and each trial was repeated 20 times for each sex for a total of 80 individuals for each sex for each cultivar. The supercooling point was defined as the lowest temperature attained before a sharp rebound visible on the thermal curve owing to the release of the latent heat of freezing.

DATA ANALYSIS

Data was tested for normality using the Kolmogorov-Smirnov test in PROC CAPABILITY and tested for homogeneity using the Levene Test for Homogeneity of Variances in PROC GLM (SAS 2013). One-way analysis of variance (ANOVA) was conducted to analyze differences in adult emergence, supercooling point, weight, and length using PROC GLM. Mean separation was performed using Tukey's Honestly Significant Difference (HSD) ($P < 0.05$).

Results

HOST PLANT RESISTANCE IMPACT ON SWEETPOTATO WEEVIL ADULT EMERGENCE

The number of adult sweetpotato weevil that emerged from a single root varied significantly between sweetpotato cultivars ($F =$ 21.75; df = 2, 147; $P < 0.0001$). Significantly more sweetpotato weevil adults emerged from roots of cultivars Beauregard and Evangeline than from Murasaki (Table 1). The number of sweetpotato weevil emerged from Murasaki was less than one-third of sweetpotato weevil adults emerged from Beauregard and approximately a quarter of those emerged from Evangeline. The resistance of Murasaki relative to Beauregard and Evangeline can be clearly seen in the daily emergence data (Fig. 1). Most adult emergence occurred 34 to 44 d after oviposition, with the earliest emergence from Evangeline (d 32) followed by Beauregard (d 33) and Murasaki (d 34) (Fig. 1). Peak emergence occurred around d 37. From 45 to 55 d after oviposition, adult emergence was very low for all sweetpotato cultivars.

HOST PLANT RESISTANCE IMPACT ON SWEETPOTATO WEEVIL ADULT MASS AND BODY SIZE

Sweetpotato weevil body weight and length were measured to evaluate the effect of host resistance on adult physical parameters. For males, weevils reared on Murasaki were the heaviest, followed by Evangeline, with those reared on Beauregard weighing the least ($F = 4.56$; df = 2, 147; $P = 0.0129$) (Table 2). Similarly, female weevils that developed on Murasaki had the highest body weight ($F = 5.74$; df = 2, 147; $P = 0.0045$) (Table 2). Although body weight varied among weevils reared on different sweetpotato cultivars, there were no differences among body lengths of male ($F = 1.92$; df = 2, 147; $P = 0.1532$) or female ($F = 1.34$; df = 2, 147; $P = 0.2665$) adults reared on different sweetpotato cultivars (Table 2).

HOST PLANT RESISTANCE IMPACT ON SWEETPOTATO WEEVIL SUPERCOOLING POINTS

Male and female sweetpotato weevil supercooling points were measured separately. Supercooling points of sweetpotato weevil males emerging from the 3 host cultivars differed significantly ($F = 3.10$; df = 2, 237; $P = 0.0500$) (Table 2). Supercooling points of males from Murasaki were significantly lower than Beauregard but similar to weevils from Evangeline (Table 2). Female sweetpotato weevil reared on different cultivars did not show any differences in their supercooling points ($F = 0.13$; df = 2, 237; $P = 0.8756$).

Discussion

Nutritional resources obtained in early life stages are critical for insect growth and are strongly correlated with adult body size and weight, both contributing to insect fitness (Awmack & Leather 2002; Colasurdo et al. 2009). Resistant or inferior hosts often interfere with development, resulting in smaller insects with lower body mass. Our study showed that sweetpotato weevil reared on resistant Murasaki were similar in body length but heavier than

Table 1. Mean (± SE) total sweetpotato weevil adult emergence in no-choice oviposition assays.

Cultivar	Sweetpotato weevil emergence[a]
Beauregard	38.9 ± 3.3 a
Evangeline	48.4 ± 6.2 a
Murasaki	11.1 ± 3.5 b
P-value	< 0.0001

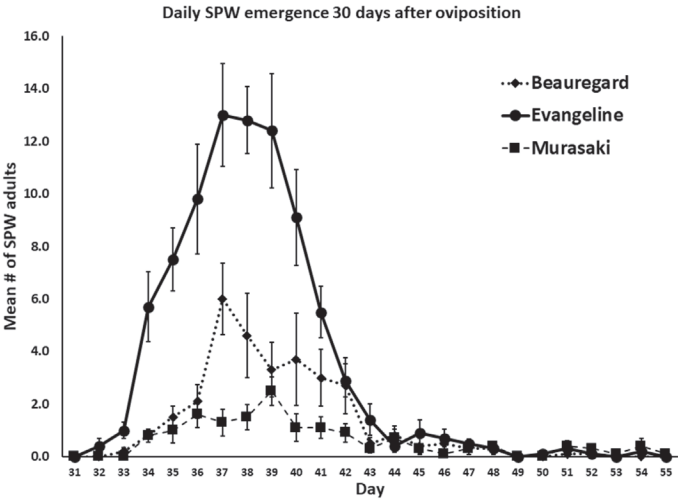[a]Means followed by same letter within rows are not significantly different (n = 50) ($P > 0.05$; Tukey's HSD).

Fig. 1. Daily (Mean ± SE) sweetpotato weevil emergence 30 d after oviposition from individual storage roots of sweetpotato cultivars 'Beauregard,' 'Evangeline,' and 'Murasaki.'

the weevils reared on Beauregard and Evangeline. The similarity in body size and weight of sweetpotato weevil reared on Beauregard and Evangeline may be attributed to the nutritional similarities between the 2 cultivars (La Bonte et al. 2008a). Murasaki, on the other hand, is higher in starch and crude protein and has less water (Cartier et al. 2017). Therefore, the differences in body weight between sweetpotato weevil colonies reared on tested cultivars could be ascribed to host quality.

Studies have shown that host nutritional properties can alter the supercooling points of insects by affecting the accumulation of cryoprotectants like glycerol, low molecular weight polyols, and unsaturated lipids (Buchanan & Storey 1983; Lee 1989; Storey & Storey 1991; Lee et al. 1993). Even a small change in the proportion of glycerol or membrane lipid can confer a considerable effect on the fluidity of extracellular sap or cell membrane and subsequently on the cold hardiness of an organism (Lee 1989; Storey & Storey 1991). Body fluid content is another important measure and is inversely related to supercooling capacity (Lee et al. 1993). Research on *Drosophila melanogaster* Meigen (Diptera: Drosophilidae) showed how cold tolerance and survival varied considerably across different diets, establishing a strong correlation between dietary composition and an insect's cold hardiness (Littler et al. 2021). Thus, a high level of starch and low moisture content in Murasaki roots may be the contributing factors in changing carbohydrate and moisture profiles of sweetpotato weevils that ultimately contribute to lower supercooling points (Cartier et al. 2017). In addition, increasing supercooling capacity is an indication of greater cold hardiness and is one of the foundations for surviving and successfully establishing in low temperature zones. So, despite being a resistant

cultivar, Murasaki may pose a risk by increasing sweetpotato weevil cold hardiness even though fewer adults survive.

Body parameters often determine the overall fitness of insect herbivores and eventually affect their capacity to combat detrimental environments including cold (Sequeira & Dixon 1996; Awmack & Leather 2002). Previous work has shown that body weight is correlated to supercooling point (Hou et al. 2009). In Asiatic rice borer, *Chilo suppressalis* (Walker) (Lepidoptera: Crambidae), larvae from water oat (*Zizania latifolia* [Turcz]; Gramineae) populations were heavier and showed lower supercooling points compared to lighter larvae fed on rice (*Oryza sativa* L.; Gramineae) (Hou et al. 2009). Our results agree with this report, showing heavier sweetpotato weevil reared on Murasaki with a lower supercooling point compared with lighter weevils reared on Beauregard or Evangeline. High level of supercooling capacity could alter the potential for sweetpotato weevils to invade further north, expanding their geographic range. For example, in Japan, a sweetpotato weevil population from low-latitude southwestern islands dispersed and established to Muroto, an infestation-free island located at a latitude higher than 30°N (Kandori et al. 2006). In the US, sweetpotato weevil first entered Louisiana in 1875, probably by way of Cuba, and over time it has spread across the southeastern coastal plain from North Carolina to Texas reflecting its capacity to acclimatize in different temperature zones (Chalfant et al. 1990; Sorensen 2009).

Besides body parameters, larval developmental time and adult emergence are 2 key factors of insect life cycle that are influenced by host plants (Hunter & Mcneil 1997; Ishihara & Ohgushi 2006; Thiéry et al. 2014). Insects grown on resistant cultivars experience an incomplete and prolonged development phase affecting adult emergence (Awmack & Leather 2002; Thiéry & Moreau 2005; Nash & Chapman 2014). Less adult emergence directly affects insect population size and thereby limits insect numbers. Evidence has been found that esters of caffeic, coumaric, and hydroxycinnamic acids on root surface and latex are active biologically in resistant sweetpotato genotypes (Snook et al. 1994; Data et al. 1996; Stevenson et al. 2009; Anyanga et al. 2013). Murasaki roots may have similar defense chemistry that may explain the resistance to sweetpotato weevil where prolonged developmental time and less adult emergence are the consequences of tackling these root inhibitory secondary metabolites (Stevenson et al. 2009; Anyanga et al. 2013). In future, a comparative study on root primary and secondary metabolites of these 3 cultivars is warranted.

It has been found that sweetpotato cultivars with different levels of resistance significantly altered the adult emergence of *Cylas* spp. in East Africa (Kabi et al. 2001; Stathers et al. 2003a, b). Supporting this finding, our study showed significantly lower sweetpotato weevil adult emergence from Murasaki roots compared to Beauregard and Evangeline. There are 2 possible hypotheses; first, female sweetpotato weevils did not prefer to lay eggs on this cultivar (i.e., antixenosis), or second, larvae developing inside Murasaki roots were not able to successfully complete the entire life cycle (i.e., antibiosis). Supporting

Table 2. Supercooling points, weights, and lengths (Mean ± SE) of male and female adult sweetpotato weevil reared on different sweetpotato cultivars[a].

Cultivar	Supercooling point[b] (°C)		Weight[c] (mg)		Length[d] (mm)	
	♂	♀	♂	♀	♂	♀
Beauregard	−16.3 ± 0.5 a	−17.0 ± 0.5 a	4.6 ± 0.1 b	4.4 ± 0.1 b	6.3 ± 0.6 a	6.2 ± 0.5 a
Evangeline	−17.1 ± 0.4 ab	−17.2 ± 0.4 a	4.7 ± 0.1 b	4.7 ± 0.1 ab	6.4 ± 0.5 a	6.3 ± 0.5 a
Murasaki	−17.9 ± 0.4 b	−17.3 ± 0.4 a	5.1 ± 0.1 a	5.0 ± 0.1 a	6.3 ± 0.8 a	6.2 ± 0.8 a
P-value	0.0500	0.8756	0.0129	0.0045	0.1532	0.2665

[a]Means followed by same letter within rows are not significantly different (P > 0.05; Tukey's HSD). [b]N = 80 for each sex. [c, d]N = 50 for each sex.

our first hypothesis, the resistance type for other sweetpotato weevil resistant sweetpotato lines like Charleston, Scarlet, Resisto, Regal, etc., was identified as ovipositional antixenosis or non-preference (Jackson 2010; Jackson & Harrison 2013). Earlier research on oviposition preference reported that female sweetpotato weevil deposited significantly fewer eggs on Murasaki roots regardless of rearing host cultivars (Chen et al. 2019). This finding aligns with a study done by Nottingham et al. (1989), which showed reduced oviposition and fewer feeding punctures by *C. formicarius elegantulus* on resistant cultivars compared to susceptible 'Centennial' cultivar. Therefore, lower emergence from Murasaki roots results primarily from non-preference of the sweetpotato weevil females rather than lack of optimal nutrition in roots required for larval development. It has been found that host epidermal secondary metabolites play a major role in insect egg laying behavior serving as ovipositional cues for many chrysomelids including *Cyclas* spp. (Wilson et al. 1989; Kays & Wang 2002; Anyanga et al. 2013; Mitra et al. 2017). Boehmeryl acetate, a pentacyclic triterpene, is a predominant root surface chemical of susceptible sweetpotato cultivars and was found to induce oviposition by sweetpotato weevil females (Wilson et al. 1989; Son et al. 1991; Marti et al. 1993). Therefore, the paucity of oviposition stimulators on the surface of Murasaki roots could be the underlying cause of lower adult sweetpotato weevil emergence.

In conclusion, our study provided information on the fitness of sweetpotato weevil reared on 3 sweetpotato cultivars and confirmed cv. Murasaki as resistant with lower adult emergence. It is recommended for growers, especially in developing countries, to incorporate resistant cultivars like Murasaki to increase sweetpotato production and reduce insecticide reliance, which will reduce management costs. We encourage breeders to develop cultivars that combine resistant characteristics with popular, orange-fleshed susceptible sweetpotato lines to produce commercially acceptable cultivars with sweetpotato weevil resistance. Weevils reared on Murasaki roots had a decreased supercooling point, likely due to increased body mass, and established a positive correlation between body weight and supercooling point. There is a particular dearth of knowledge on how primary and secondary chemicals of different sweetpotato cultivars affect herbivores' morphological parameters and supercooling points, and therefore requires further work on biochemical basis of sweetpotato cultivars and their effects on sweetpotato weevil physiology.

Acknowledgments

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