Southern Green Stink Bug, Nezara viridula (L.), Injury to Macadamia Nut[1]

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INTRODUCTION

The kernel spotting of macadamia (*Macadamia ternifolia* F. Muell.) was first noticed on October 8, 1962, in nuts harvested from trees in Nuuanu Valley, Oahu. Additional reports of kernel damage were received from Waipahu and Ewa a few days later. The injury appeared very similar to kernel spot of pecan reported by Turner (1918), Demaree (1922), Weber (1933), Moznette (1940) and Phillips et al (1964).

The feeding damage of the southern green stink bug, *Nezara viridula* (L.), on nut crops has been known since 1917 when Turner reported that kernel spot of pecan was caused by the feeding of this stink bug. Demaree was able to reproduce the spotting of pecan kernels in the laboratory by allowing stink bugs to feed on undamaged nuts. Demaree and Weber were primarily interested in the micro-organisms associated with the feeding punctures. They isolated a number of bacteria and fungi but none were consistently found in each spotted kernel. Weber isolated the fungus *Nematospora coryli* Pegl. from spots on the pecan kernels. Dr. Rutschky, a visiting professor from Pennsylvania State University, did some preliminary investigation of the micro-organisms and factors associated with the kernel spot of macadamia in Hawaii. He reported one bacterium and three fungi were isolated from macadamia kernel spots.

MACADAMIA INJURY

Stink bug injury to plants is caused by the feeding of the second to fifth instar nymphs and adults (Fig. 1). The first nymphal instar does not feed on plant tissue but may ingest water. The insect will feed on macadamia in any stage of development. Though all stages in the life cycle of the insect have been observed in the field on macadamia, only one egg mass has been collected on macadamia foliage to date, which indicates other plant hosts are more favorable for egg deposition.

The kernel injury (Fig. 2) usually is not recognized until the nuts have been shelled and the spotting of the kernels is evident. The stink bug is able to

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Table 1. Percentage* of stink bug damaged macadamia kernels from samples taken at four orchards on Oahu in 1963 and 1964

Orchard Location	Orchard Altitude (Feet)	Harvest Season	Number of Kernels Sampled	Month						Mean Seasonal Damage
				Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	
Nutridge	900–1000	1963	407–513	0.6	1.1	1.2	1.5	0.8	0.4	0.9
		1964	154–348	0.0	0.0	1.2	0.0	0.0	0.5	0.3
Poamoho	500–600	1963	242–336	9.8	13.2	12.6	—	6.8	8.3	9.9
		1964	320–847	—	0.0	0.0	0.0	0.2	0.6	0.2
Waialua	250–300	1963	585–608	7.4	14.3	16.1	—	9.2	6.4	10.7
		1964	455–857	—	0.6	0.0	1.1	0.4	1.4	0.7
Waimanalo	50–100	1963	400–509	66.5	52.8	62.5	55.7	55.8	45.7	56.2
		1964	412–1136	5.9	7.5	6.5	6.3	8.5	7.0	7.2

* Actual count of stink bug damage both in the nuts which floated and nuts which sank in water.

penetrate through the husk and shell of a mature nut to reach the kernel. A single kernel may have from one to seventy or more feeding punctures. The feeding sites, usually localized, are circular with a definite margin and characterized by a dry, cottony, pithy or punky depression. The feeding site may be discolored if micro-organisms enter and cause further decomposition. The kernel spots did not have the bitter off taste reported for kernel spot of pecan. Demaree and others believe the kernel damage on pecan is entirely due to mechanical injury of the host cells at the time of feeding, to the sucking of plant juices, and the injection of toxic substances into the tissues or a combination of all three. Damage to macadamia appears to be of the same order. Spotting of the macadamia kernels was produced in the laboratory by exposing undamaged nuts to stink bugs.

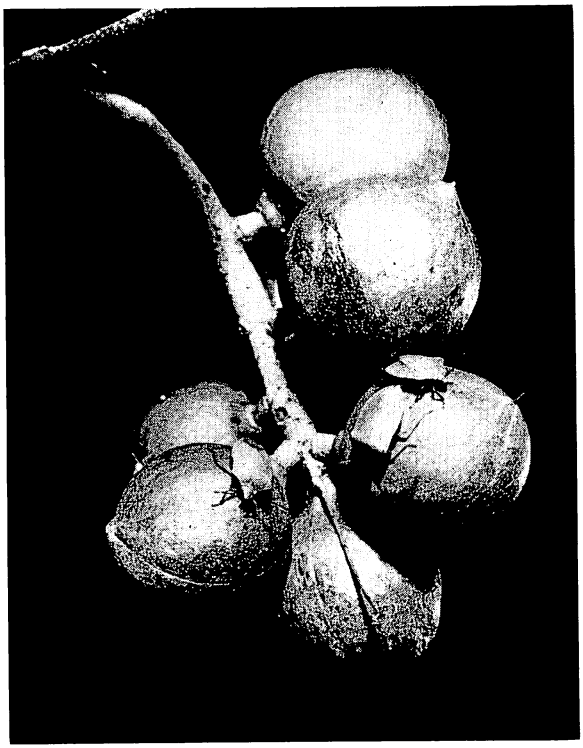

FIGURE 1. Adults of *Nezara viridula* feeding on macadamia nuts.

MATERIALS AND METHODS

To ascertain the extent of injury to macadamia by *Nezara viridula* (L.), four orchards on Oahu, namely Waialua Plantation, Poamoho Experiment Station, Waimanalo Experiment Station and Nutridge were sampled each month (August

through January) for the past two harvest seasons. When the stink bug was found on the island of Hawaii (June, 1963) the macadamia kernel injury was followed closely at the Kona Branch Experiment Station, Kealakekua, Hawaii.

Green husk nuts were picked from the ground, husked, dried, shelled, and examined for stink bug feeding injury. All kernels were graded by flotation in water: No. 1 (floaters) are processed and sold at the highest price; No. 2 (sinkers) are used in lower grade products, rat baits, etc.

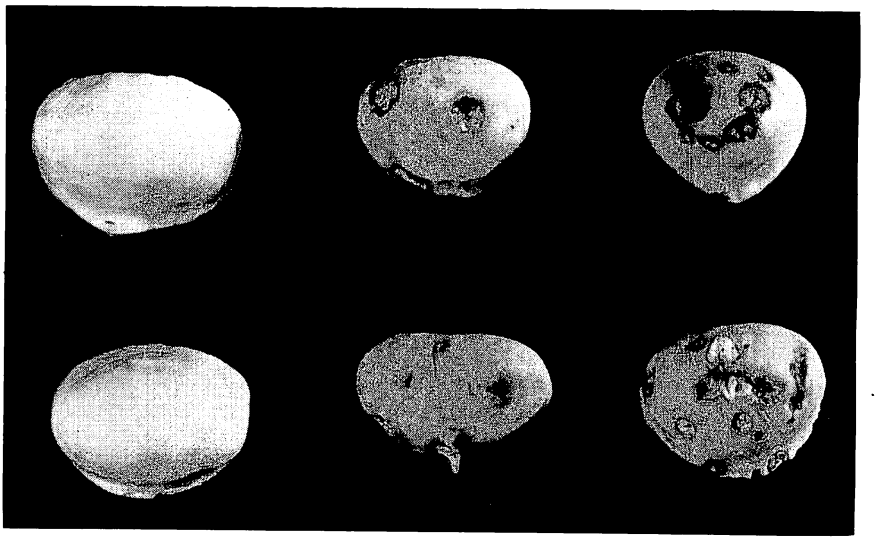

FIGURE 2. Kernel spots on macadamia caused by stink bug feeding. Left column, normal kernels; center and right columns, damaged kernels.

The Waimanalo, Kona, and Poamoho Experiment Station plantings were varietal seedling orchards while the Nutridge and Waialua orchards contained standard producing commercial varieties.

RESULTS

Samples of macadamia nuts were collected monthly from the four orchards on Oahu during the 1963 and 1964 harvest seasons and the percentage of damaged kernels from stink bug feeding is given in Table 1.

Nutridge (Honolulu, Oahu): This orchard has not been kept up in the best manner for it was overgrown with weeds and interspersed with vegetable plantings that were attractive to the stink bug. Stink bugs were observed on the weed and vegetable hosts, but not on the macadamia plants. Weekly observations during the 1964 season showed stink bugs present on the weeds and

vegetable hosts up to the middle of September and then absent until December. Activity of the adult stink bug parasite, *Trichopoda pennipes* var. *pilipes* (F.), was observed through the middle of October. Mean stink bug injury was 0.9 and 0.3 percent for 1963 and 1964 respectively. Among the four orchards, Nutridge had the lowest injury in 1963 and was second lowest in 1964.

Table 2. Percentage* of No. 2 macadamia kernels in samples taken for stink bug injury at four orchards on Oahu in 1963 and 1964

Orchard Location	Harvest Season	Range in Sample Size (No. Kernels)	Month					
			Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Nutridge	1963	407–513	33.9	13.4	10.3	7.6	11.5	4.2
	1964	154–348	19.0	13.3	9.8	11.6	9.8	18.3
Poamoho	1963	242–336	10.2	9.1	5.1	—	2.9	2.5
	1964	320–847	—	6.3	6.3	6.4	5.0	6.3
Waialua	1963	585–608	15.1	10.6	4.6	—	4.8	4.9
	1964	455–857	—	3.4	2.6	3.5	5.9	4.7
Waimanalo	1963	400–509	49.8	13.2	9.7	7.3	7.0	6.2
	1964	412–1136	6.0	7.1	7.9	3.4	3.6	4.5

* Determined by actual count of sinkers in the samples.

Poamoho Experiment Station (Poamoho, Oahu): The ground beneath the trees is kept clean of grass and debris. The planting is rather isolated from any stink bug hosts. A number of trees were damaged by the high winds and rains in 1964. No stink bugs were observed feeding in the orchard. Mean kernel damage was 9.9 and 0.2 percent for 1963 and 1964 respectively. Poamoho had the lowest injury in 1964 and was second lowest in 1963.

Waialua Plantation (Waialua, Oahu): This orchard has areas of grass and weeds between the blocks of trees. The area beneath the canopy of the macadamia trees was cut and raked clean. The orchard is located near a refuse dump where burning causes a pall of smoke to cover the planting most of the time. The leaves of many trees were covered with soot. A portion of the orchard caught fire and was destroyed in the early part of the 1964 season. Stink bug adults have been observed feeding on nuts several times. The area is isolated from vegetable plantings and other hosts that are attractive to stink bugs. The mean seasonal kernel damage was 10.7 and 0.7 percent for 1963 and 1964 respectively. Waialua had the second highest injury of the four orchards during both harvest seasons.

Waimanalo Experimental Farm (Waimanalo, Oahu): The greatest damage to macadamia from feeding of the stink bug for 1963 and 1964 occurred in this orchard. The ground beneath the trees was bare. The planting was surrounded by experimental corn, tomato, alfalfa, and bean plantings that produced many stink bugs. When these hosts were harvested, the stink bugs migrated to

other areas. Some of them moved to the macadamia trees and started feeding. All stages of the life cycle of the stink bug have been observed on trees in these plantings. Adult stink bug parasite activity was observed in the surrounding vegetable and alfalfa plantings but was absent in the orchard. The experimental farm is located in the center of truck farming. Mean kernel damage from stink bug feeding was 56.2 and 7.2 percent for 1963 and 1964 respectively.

One 2-acre orchard of the Keauhou variety was sampled weekly throughout the 1963 and 1964 harvest season. Eleven samples ranging from 301 to 899 nuts were sampled in 1963 and nineteen samples ranging from 1,071 to 1,872 were examined in 1964. Mean in stink bug damaged kernels was 45.1 percent in 1963 and 9.3 percent in 1964.

It is interesting to note that stink bug feeding injury was highest in both harvest seasons in plots at the lowest elevation (Table 1). The significance of this is not immediately clear. The marked decrease in macadamia kernel injury in the 1964 harvest season was probably the result of the combination of introduced parasites and spray programs of ornamental and truck farmers in decreasing the stink bug population.

Kona Branch Experiment Station (Kealakekua, Hawaii): The harvest season is continuous here throughout the year. Kernel injury began to appear in February, 1964, about eight months after the stink bug was discovered on the island of Hawaii. Monthly injury through December, 1964, ranged from 0.5 to 69.9 percent. The planting is divided into two orchards, Field A and Field B. Field A at approximately 1,500 feet altitude was lower and had the heaviest damage.

Premature nut drop is a constant problem in macadamia orchards. Harvested samples were graded to determine if the feeding injury caused any premature drop. If a premature drop occurred as a result of stink bug feeding the samples should contain a higher percentage of sinkers (No. 2). The percentages of No. 2 (sinkers) in the samples at the four orchards on Oahu are given in Table 2. The high percentages of 33.9 and 49.8 in the samples taken in August, 1963, at Nutridge and Waimanalo respectively, were at the beginning of the season and not too far out of line. The small number of sinkers in the other collections was normal. These data when considered with the stink bug damage shown in Table 1 indicate that stink bug feeding does not cause a premature drop. This is substantiated by other unpublished data which showed that stink bugs caged with developing nuts did not produce premature drop.

SUMMARY

Stink bug damaged macadamia nut data are given for the 1963 and 1964 harvest seasons in four orchards on Oahu. The highest mean seasonal damage was 56.2 percent in 1963 and 7.2 percent in 1964. Feeding damage markedly decreased in 1964 in all four orchards. Harvested kernels were graded into No. 1 (floaters) and No. 2 (sinkers) by flotation in water. Data presented indicate that feeding injury does not cause a premature drop of macadamia nuts.

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