Economic Damage and Host Preference of Lepidopterous Pests of Major Warm Season Turfgrasses of Hawaii[1]

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ABSTRACT

The four major lepidopterous pests of turfgrasses of Hawaii are the grass webworm, *Herpetogramma licarsisalis* (Walker), (GWW); lawn armyworm, *Spodoptera mauritia* (Boisduval), (LAW); black cutworm, *Agrostis ipsilon* (Hufnagle), (BCW); and fiery skipper, *Hylephila phylaeus* (Drury), (FS). The effects of different densities of larvae of these four insects on development of feeding injury to 'Sunturf' bermudagrass, *Cynodon magennisii* (Hurcombe), were determined in 12.7 cm diameter pots in a glasshouse. Effects of diets of different turfgrasses on larval development and survival of the GWW and FS were determined in the laboratory.

Complete consumption of 'Sunturf' bermudagrass occurred in 6-7 days with populations of greater than 3 LAW, 4 BCW, 10 FS, and 12 GWW. All population levels of LAW and BCW caused serious injury (greater than 20% of turf consumed) 4-5 days after adding third instar larvae to pots. One FS and one or two GWW larvae per pot caused only slight feeding injury.

Developmental rate and survival of the GWW were poorest on 'Tifgreen' and common bermudagrass. FS larvae developed more slowly when fed *Zoysia matrella* (L.) and centipedegrass, *Eremochloa ophiuroides* ((Munro.) Hack). All FS larvae fed St. Augustinegrass, *Stenotaphrum secundatum* ((Walt.) Kuntz.), died after 7-8 days.

The most commonly occurring insect pests of turfgrasses in Hawaii are the "lawn caterpillars", or larvae of lepidopterous insects. The grass webworm (GWW), *Herpetogramma licarsisalis* (Walker), is the most important (Tashiro 1976). The lawn armyworm (LAW), *Spodoptera mauritia* (Boisduval), also frequently causes serious injury. The black cutworm (BCW), *Agrotis ipsilon* (Hufnagel), and the fiery skipper (FS), *Hylephila phylaeus* (Drury), feed on turfgrasses, but outbreaks of these species occur less frequently than those of the GWW and LAW.

In previous work, we found differences in the amount of feeding injury by the grass webworm on different turfgrasses (Murdoch and Tashiro 1976). Little is known of the host preference of the other lawn caterpillars. We also know little about the population of the different larvae required to cause economic demage to turfgrasses in Hawaii. Research on insecticidal control of turf caterpillars has been conducted for many years (Mitchell and Murdoch 1974; Murdoch and Mitchell 1972, 1975, 1978).

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Data on insect feeding injury as well as insect populations have always been obtained, but correlations of insect numbers with feeding injury in field experiments can be misleading. Feeding injury may be from previous generations of insects. Other stresses may also cause injury which can be confused with insect feeding damage. Because of lack of information on host-insect interactions of the major turfgrass pests of Hawaii, we conducted glasshouse and laboratory experiments to determine the effects of larval populations of the four lawn caterpillars on development of feeding injury to 'Sunturf' bermudagrass, and to determine the effects of diets of different turfgrasses on larval development of the grass webworm and fiery skipper.

MATERIALS AND METHODS

I. Effect of number of larvae of LAW, GWW, FS, and BCW on feeding injury to 'Sunturf' bermudagrass.

Field captured adults or field collected larvae reared to adults were used to start cultures. Adults were held in square screen cages 24 cm by 24 cm in an environment conducive to mating and oviposition. LAW, GWW and BCW were held in a controlled environment chamber with day-night temperatures of 29-28 C, 12 hr light-dark periods and 70 to 80% relative humidity. Field collected fiery skipper adults were held in screen cages in the glasshouse. Adults were provided honey solution dispensed from moist cotton. When sufficient numbers of eggs were obtained they were held in petri dishes containing moist filter paper and sections of young sweet corn or bermudagrass leaves. Fresh leaves were supplied daily as larvae developed.

Different numbers of third instar larvae of the LAW, GWW, FS, and BCW were placed on the surface of 'Sunturf' bermudagrass (*Cynodon magennisii* Hurcombe) growing in 12.7 cm diameter plastic pots arranged on a glasshouse bench in a randomized complete block design with 5 replications. Pots of grass were selected which had a uniform, dense stand. A preliminary test made by introducing newly hatched larvae of the LAW into potted turf resulted in high larval mortality. Additionally, there was a 10 to 14 day delay before any feeding injury became evident. We therefore decided to introduce third instars of all species to reduce larval mortality and to obtain more rapid evidence of feeding injury. Because of differences in size between species of larvae, different numbers of individuals were used for each species tested. It was assumed that larger numbers of small larvae would be required to cause serious feeding injury. Tests with the different insects were conducted at different dates, although some tests overlapped, becuase of the large number of pots of grass needed and logistics of rearing larvae for testing.

Larvae were carefully placed in the pots of 'Sunturf' which were watered daily with a fine mist nozzle to prevent injuring the larvae. A sleeve of transparent acetate plastic 20 cm high was fitted into the pots inside the rim to prevent larvae from escaping. Feeding ratings were made on a scale of 0-10 with 0 being no visible feeding injury and 10 being complete consumption of the turf. Ratings of feeding injury were started one day after larvae were introduced and continued until either a rating of 10 was obtained or until the turf began to recover, indicating cessation of feeding and start of pupation. Ratings were usually made by two individuals and averaged. On some occasions only one person was available for rating the grasses. The averages of the two observers on days when both were present were close enough to consider either reliable. All experiments were completed in 7 to 8 days after adding larvae to the pots. Duration of experiments, numbers of larvae added, and glasshouse temperatures during the experiments are given in Table 1.

TABLE 1. Duration of the different experiments, insect populations used, and glasshouse temperatures in experiments to determine effects of larval populations on development of feeding injury to 'Sunturf' bermudagrass.

Insect	Days for completion of experiment	Larval density (no./pot)	Glasshouse temp. (°C) Av. daily high & range	Av. daily low & range
Lawn armyworm	7	0, 1, 2, 3, and 4	40 (38-41)	21 (21)
Black cutworm	7	0, 1, 2, 3, and 4	40 (36-41)	21 (20-21)
Fiery skipper	6	0, 1, 3, 7, and 10	37 (32-41)	20 (18-21)
Grass webworm	6	0, 2, 4, 8, and 12	41 (39-42)	23 (22-23)

Analysis of variance was performed on the feeding injury data after converting the injury ratings to percent and transforming to arc-sine values. Bayes LSD (Waller and Duncan, 1969) was used to compare differences between treatment means.

II. Effect of diets of different turfgrasses on survival and larval development of grass webworm and fiery skipper.

Laboratory cultures of the GWW and FS were established by methods discussed above. Six first instar larvae were placed on filter paper discs, slightly moistened with water, in 9 cm glass petri dishes and fed young leaves of the different turfgrasses. Leaves were clipped daily from pots maintained in the glasshouse and added to the dishes in excess of consumption to ensure a continuous supply of food. Grass and old leaves were removed from the petri dishes and filter paper discs were changed as needed. The dishes were maintained in a controlled environment chamber with 12 hour light-dark periods, day and night temperatures of 29-28 C, and 70 to 80% relative humidity. Numbers of larvae surviving and their stadia were determined daily and recorded. Larval stadia were determined by measuring head capsule widths. Preliminary studies had shown head capsule widths of the instars as given in Table 2.

TABLE 2. Length and head capsule diameter of the instars of the grass webworm and fiery skipper larvae.

	Insect			
	Grass webworm		Fiery skipper	
		Head capsule		Head capsule
Larval instar	Length (mm)	Diameter (mm)	Length (mm)	Diameter (mm)
First	2.3	0.25	3.0	0.40-0.50
Second	4.5	0.40	6.0	0.75
Third	7.0	0.70	8.0-10.0	1.20
Fourth	11.1	1.00	13.0-16.0	1.80
Fifth	20.0	1.80	20.0-25.0	2.70-3.00

Grasses fed the grass webworm larvae were: 1) 'FB-137' bermudagrass, *Cynodon dactylon* ((L) Pers.); 2) 'Tifway' bermudagrass, *C. dactylon* X *C. transvaalensis* (Burtt-Davey); 3) common bermudagrass, *C. dactylon;* 4)'Tifgreen' bermudagrass, *C. dactylon* X *C. transvaalensis;* 5) centipedegrass, *Eremochloa ophiuroides* ((Munro.) Hack); and 6) seashore paspalum, *Paspalum vaginatum* (Sw). Fiery skipper larvae were fed the same plus *Zoysia matrella* ((L.) Merr.) and St. Augustinegrass, *Stenotaphrum secundatum* ((Walt.) Kuntz.).

There were five replications of each grass with six larvae per replication for a total of 30 larvae on each grass. Analysis of variance was performed on arc-sine transformed data for percent of larvae surviving at selected dates after initiating the tests and percent of larvae reaching the pupal stage. Bayes LSD (Waller and Duncan 1969) was used to compare differences between treatment means.

RESULTS

I. Effect of number of larvae of LAW, GWW, FS, and BCW on feeding injury to 'Sunturf' bermudagrass.

Densities of GWW larvae of 2 and 4 per pot caused only slight turf injury (Figure 1a). Serious damage was caused by 8 and 12 per pot after 4 days, with near complete destruction of the turf by 12 larvae per pot. Densities of LAW greater than 3 per pot completely consumed 'Sunturf' bermudagrass in 5 to 6 days (Figure 1b). Turf was not completely destroyed at densities less than this, but noticeable damage to turf was apparent in 4 to 6 days with 1 per pot, and in 2 to 3 days with 2 per pot. All densities of the BCW tested caused serious feeding injury, with near complete consumption of the turf by 3 or 4 per pot (Figure 1d). Even 1 BCW larva per pot caused serious feeding injury after 4 to 5 days. Complete consumption of turf by FS larvae occurred with 10 per pot after 6 days (Figure 1d). Turf was not completely consumed by 3 or 7 per pot, but these densities did cause serious damage after 2 to 3 days. One FS larva per pot caused only slight damage to the turf during the entire 8 day test period.

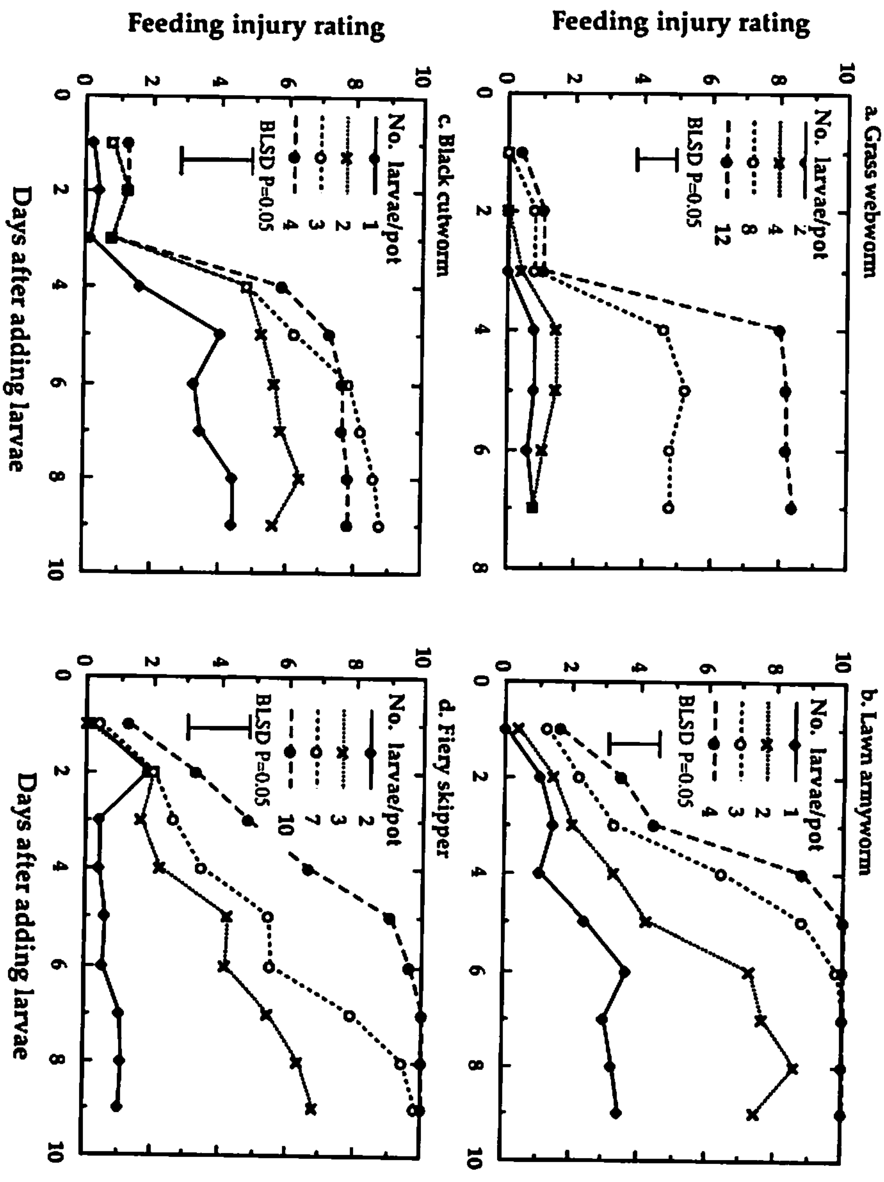

FIGURE 1. Feeding injury to 'Sunturf' bermudagrass by larvae of the grass webworm, lawn armyworm, black cutworm and fiery skipper after adding different numbers of third instar larvae to 15 cm diameter pots in the greenhouse.

II. Effect of diets of different turfgrasses on survival and larval development of grass webworm and fiery skipper.

Larval development of the grass webworm differed little on diets of 'FB-137' bermudagrass, 'Tifway' bermudagrass, centipedegrass, and seashore paspalum. Development to the pupal stage was completed in 11 to 13 days on these grasses. Development was slower on common bermudagrass, with larvae remaining as fifth instars after 11 to 13 days. On a 'Tifgreen' bermudagrass diet, larvae of the grass webworm were still fourth instars after 11 to 13 days. Survival of GWW larvae was also poorest on common and 'Tifgreen' bermudagrass (3% and 7% respectively, Table 3). Survival was best on seashore paspalum followed by 'FB-137' bermudagrass, 'Tifway' bermudagrass, and centipedegrass.

TABLE 3. Percent survival of grass webworm larvae on different turfgrasses.

Grass	Days after feeding initiated				% Pupating
	2	4	6	8	
	percent surviving				
'FB-137' bermudagrass	83 a-c*	66 a-e	60 b-f	47 e	20 bc
'Tifway' bermudagrass	87 ab	73 a-d	64 b-e	49 e	30 ab
Common bermudagrass	89 ab	73 a-d	63 b-e	43 e	3 c
'Tifgreen' bermudagrass	67 a-e	56 c-e	56 c-e	53 d-e	7 c
Centipedegrass	73 a-d	73 a-d	63 b-e	63 b-e	30 ab
Seashore paspalum	93 a	90 ab	90 ab	47 e	50 a

*Means followed by the same letter are not different at the 0.05 level as determined by the Waller Duncan Multiple Range Test (11). Compare % pupating separately.

Larval development of the FS was much slower than that of the GWW and was also affected more by diet. FS larvae fed 'FB-137' bermudagrass developed at a faster rate than those fed other grasses and had pupated after 20 days. There was little difference in rate of development on 'Tifway', common, and 'Tifgreen' bermudagrass, and seashore paspalum, with larvae being fifth instars after 20 days. Larvae fed Manilagrass and centipedegrass developed much slower and were still in fifth instar after 20 days. All larvae fed St. Augustinegrass died after 7 to 8 days (Table 4). Best survival, as measured by number of larvae pupating, was on 'FB-137' bermudagrass and centipedegrass. Larvae fed 'Tifgreen' bermudagrass were mistakenly given grass treated with an insecticide and killed just prior to pupation.

TABLE 4. Percent survival of fiery skipper larvae on different turfgrasses.

Grass	Days after feeding initiated 2	4	8	12	16	% Pupating
	percent surviving					
'FB-137' bermudagrass	83 c-e*	83 ce	80 c-e	73 e-f	73 ef	63 ab
'Tifway' bermudagrass	77 d-f	67 fg	60 gh	46 ij	43 ij	49 bc
Common bermudagrass	97 a	93 ab	90 a-c	86 b-d	86 b-d	47 a-c
'Tifgreen' bermudagrass	93 ab	80 c-e	80 c-e	83 c-e	73 ef	—†
Centipedegrass	83 c-e	80 c-e	70 e-g	70 e-g	67 fg	68 a
Seashore paspalum	83 c-e	80 c-e	53 hi	50 h-j	50 h-j	47 a-c
Manilagrass	90 a-c	50 h-j	43 ij	37 j	40 ij	37 c
St. Augustinegrass	97 a	13 k	0 l	0 l	0 l	0 d

*Means followed by the same letters do not differ at the 0.05 level as determined by Waller Duncan Multiple Range Test (11). Compare % pupating separately.
†Larvae fed 'Tifgreen' bermudagrass were mistakenly given insecticide treated leaves on the 21st day and all died.

DISCUSSION

These data show that fairly high populations of some of the lawn caterpillars are required to cause serious feeding injury to turfgrasses. Recommendations from California (Jefferson et al. 1959) state that turf should be treated with insecticides if more than 6 cutworms, 12 skipper larvae, or 18 sod webworm larvae per square meter are present. In our tests, populations of GWW equivalent to 158 and 315 per square meter and of the FS of 79 per square meter caused only slight injury before pupation occurred. The reason for these disparities is not known. The method of determining insect populations and the basis for recommendations were not given by the California workers.

There are effective biological control agents for the lawn caterpillars. Tanada and Beardsley (1958) listed many of the natural enemies of the LAW. Davis (1969) listed those of the GWW. Many of these biological agents are insects. Indiscriminate insecticide application would undoubtedly reduce their number. We have published a simple, accurate method of determining number of lawn caterpillars present in an area (Tashiro et al., 1983). For most effective lawn caterpillar control, insecticide applications should only be made when counts indicate that sufficient numbers are present to cause noticeable damage to turfgrasses.

Larval development and survival of the GWW was poorest on common and 'Tifgreen' bermudagrass. It was previously shown (Murdoch and Tashiro 1976) that common bermudagrass suffered less feeding injury by

GWW larvae than any other grasses tested. 'Tifgreen' bermudagrass was not included in that test. In the previous experiment, number of larvae surviving was poorest on Kikuyugrass, *Pennisetum clandistinum* (Hochst. ex Chiov.), and not significantly different on other grasses tested. Both this study and previous work with the GWW indicate tht sufficient differences exist in host reaction to populations of lawn caterpillars to enable selection of turfgrasses for specific situations which would be less susceptible to attack.

Larval development of the FS proceeded at the fastest rate on 'FB-137' bermudagrass and was slowest on Manilagrass and centipedegrass. Larvae fed St. Augustinegrass did not survive more than 7 to 8 days. Best survival of FS larvae was also on the grass ('FB-137' bermudagrass) on which development was fastest.

The existence of differences among cultivars of bermudagrass in larval survival and rate of larval development of the GWW and FS indicate that breeding programs for resistance to these caterpillars would be justified.

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