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Chapter 49 Growth, Survival, and Damage Relationships of White Grubs In Bermudagrass Vs. Tall Fescue

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ABSTRACT

Third instar growth and survival, and the effect of larval density of the Japanese beetle, *Popillia japonica* Newman and the southern masked chafer, *Cyclocephala lurida* (Olivier) were evaluated on Tifway bermudagrass, *Cynodon dactylon* (L.) and KY-31 tall fescue, *Festuca arundinacea* Schreb. in a three- year field study. Winter survival was sometimes enhanced in bermudagrass plots. Larval weight gain, however, was more often favored by feeding on fescue. Percent survival after 8-9 months was greatest when initial infestation levels were 3 per 0.02 m^2 microplot or fewer. Average survival ranged from 10.8 to 76%, depending upon turfgrass species, white grub species, and year of study. Little reduction in whole plant dry weight or in periodic top growth measurements was observed in these irrigated plots.

INTRODUCTION

Managed turfgrasses are subject to infestation and damage by a variety of pests. Among the most injurious are the larval stage of several species of scarabaeid beetles, commonly referred to as white grubs (Tashiro 1987, Potter & Braman 1991). At least ten species of grubs commonly damage turf directly by feeding on the roots or as a result of burrowing activity.

Japanese beetle, *Popillia japonica* Newman and southern masked chafer, *Cyclocephala lurida* (Olivier) are widely distributed, serious pests of turfgrass, ornamentals, and agronomic crops (Tashiro 1987). Seasonal population dynamics, influence of moisture on emergence, survival and oviposition, use of pheromones in management, and behavioral ecology on these and other white grub species have been subjects of extensive study (e.g., Potter 1980, 1981, Regniere et al 1981, Villani & Wright 1988). Soil inhabiting turf pests are among the most difficult to manage. Contributing factors include lack of practical and reliable sampling and monitoring strategies, the lack of understanding of interactions between pests, control tactics and the environment, and the difficulty in establishing meaningful action thresholds (Villani & Wright 1990).

The influence of larval feeding by *P. japonica* and *C. lurida* has been studied on bluegrass turf (Ladd & Buriff 1979, Potter 1982). Turf receiving regular irrigation and adequate rainfall was found to mitigate negative effects of grub infestations as high as 24 per 0.1m^2 feeding for 4 weeks (Potter 1982). Yields from pots maintained at 90% of field capacity were 34- 55% greater than yields from pots with soil moisture maintained at 60% when infested with third stage *P. japonica* larvae.

Research reported here was undertaken to further define the influence of these two white grub species on KY-31 tall fescue, *Festuca arundinacea* Schreb. and Tifway bermudagrass, *Cynodon dactylon* (L.) Pers. under conditions of adequate moisture and to determine mid to late season growth, survival, and comparative potential for damage of *P. japonica* and *C. lurida*.

MATERIALS AND METHODS

Turfgrass cores 15 cm in diameter were removed each year (89-91) during May using a golf course type cup cutter and allowed to re-establish in 15 cm diameter PVC tubes (0.02 m^2 surface) buried in the ground a depth of 30.5 cm. Masked chafer larvae collected from a fescue home lawn in Spalding Co., Ga were used to infest the tubes on 6 October, 1989. During 1990 and 1991 southern masked chafers collected at light traps and Japanese beetles collected in attractant traps were caged on 1.5 m diameter children's wading pools filled with soil and seeded with KY-31 tall fescue the previous fall. Third instar grubs were harvested from the pools and used to infest the tubes on 1 September 1990 and 9 September 1991. Screens in the bottom of the tubes permitted drainage but prevented escape of larvae.

Each treatment (tube containing each density of grubs) was replicated eight times in a completely randomized design during each year. Larvae were weighed prior to infestation. Treatments in 1989 were 0, 1, 2, 3, 4, 5, or 6 *C. lurida* per 0.02 m^2 area. Infestation levels during 1990 and 1991 were 0, 3, 9, or 15 *P. japonica* or 0, 3, 9, 15, or 21 *C. lurida*.

The soil was a cecil sandy loam. Microplots were irrigated as needed during the re-establishment phase. After infestation, fescue and bermudagrass plots were irrigated with 0.6 cm and 0.3 cm water, respectively, in the evenings during September and October. Rain guards on the irrigation system turned the irrigation off when there was more than 0.3 cm precipitation per day.

Fescue and bermudagrass plots were clipped to 5 cm and 2.5 cm, respectively, prior to infestation. Regrowth during the experimental interval was measured on 1 March 1990 by recording height above the surface. Fescue clippings of growth greater than 0.5 cm were oven dried at 48°C for 4 days and weighed. The number of green shoots per 1.3 cm^2 also was measured on 28 February 1990. Plots were destructively sampled on 27 April 1990. Larvae were recovered and weighed. Soil was washed from the roots, plants were oven dried for 7 days, and whole plant dry weights were recorded.

During 1990-1991 top growth was measured on 17 October, 28 November, 12 February, and 20 March before final, whole plant samples were taken on 1 May, 1991. Larvae were again recovered and weighed. Top growth measurements during the final year of study were obtained on 9 October, 5 November, 6 December, 1991, 6 January, 6 February, and 6 March prior to harvest on 6 April 1992. Growth and survival of each grub species in fescue vs bermudagrass were compared using Students *t*-test. Grass top growth (height and weight), and whole plant dry weights were compared within a grass species using the SAS GLM procedure (SAS 1985). Mean separation was achieved using a least significant difference test (Sokal and Rohlf 1981).

RESULTS

Larval survival varied with turfgrass species, white grub species, and year of study (Table 1).

Table 1. Survival and weight gain of southern masked chafers (SMC) and Japanese beetles (JB) on two grass species.

Year	Grub species	Tall fescue $\bar{x} \pm SE$ % survival	$\bar{x} \pm SE$ wgt gain (mg)	Bermudagrass $\bar{x} \pm SE$ % survival	$\bar{x} \pm SE$ wgt gain (mg)
1989-1990	SMC	26.4 ± 5.4^{*+}	180.2 ± 13.9*	76.0 ± 6.5	118.9 ± 14.3
1990-1991	SMC	10.8 ± 2.6^{ns}	399.8 ± 12.4*	10.9 ± 2.7	311.7 ± 14.2
	JB	28.2 ± 5.6^{ns}	122.2 ± 11.5^{ns}	37.9 ± 4.9	102.0 ± 8.7
1991-1992	SMC	38.6 ± 10.0^{ns}	153.4 ± 16.8^{ns}	41.5 ± 12.7	150.1 ± 17.6
	JB	57.0 ± 10.6^{ns}	57.7 ± 13.3*	32.8 ± 9.5	25.9 ± 7.2

* $P < 0.05$

\+ Comparisons of survival or weight gain between grass species for each grub species.

Survival ranged from 10.8% (*C. lurida*, fescue, 1990/91) to 76% (*C. lurida*, bermudagrass, 1989/90). Survival was significantly ($P < 0.05$) greater for both grub species when bermudagrass was the turfgrass host during 1989/90. During 1990/1991 and 1991/92, survival on bermudagrass was not significantly greater than on fescue ($P > 0.05$). Average larval weight gain during the trial period was generally greater when grubs were caged on fescue ($P < 0.05$).

Significant reductions in final whole plant dry weights were detected only when the dry weights were compared with final infestation levels of grubs recovered from plots during 1989/1990 (Table 2).

Table 2. Influence of SMC larval feeding on season-long plant growth during 1989 as measured by initial infestation level (IIL) and final number of larvae recovered (FNL) per 0.02 m^2

	$\bar{x}$ + SE total plant dry weight (gm)			
	Tall fescue		Bermudagrass	
No. of larvae	IIL	FNL*	IIL	FNL
0	102.5±73.5	101.6±8.6	62.3± 7.7	73.5±12.1
1	93.3±63.9	94.7±4.3	64.0± 8.8	63.9±13.6
2	90.6±62.5	83.0±4.0	86.1±17.9	62.5± 8.2
3	95.3±62.8	77.0±5.8	55.0± 4.9	62.8± 8.8
4	90.2±72.0		64.5± 8.3	72.0± 8.2
5	103.5±55.5		58.5± 8.9	55.5± 8.8
6	86.4±58.4		73.1±15.2	58.4±10.1

* $P < 0.05$

No density related reductions in plant final dry weights were detected during the subsequent two years (Table 3). Clipping heights and dry weights measured on 12 occasions during three years in these irrigated plots never revealed a grub density related reduction in growth. The rate at which winter dormant bermudagrass resumed growing as measured by number of green shoots per cm^2 was not significantly related to infestation level ($P > 0.05$). Density related damage might have been much more evident had the entire larval feeding period been measured or had drought stress been induced.

Table 3. Influence of larval feeding on season-long plant growth during 1990 and 1991 by Souther masked chafer (SMC) and Japanese beetle (JB)

	$\bar{x}$ + SE total plant dry weight (gm)			
	Tall fescue		Bermudagrass	
No. of larvae	SMC	JB	SMC	JB
		1990		
0	101.2±11.5	101.2±11.5	109.2±12.8	109.2±12.0
3	112.9±22.8	73.8±16.6	151.1±22.4	110.4±15.7
9	85.7± 8.2	87.7±17.6	95.8±11.8	135.2±19.0
15	114.4±19.7	118.1±21.7	123.1±15.0	76.9± 6.9
21	114.1±16.6		79.4±16.6	
		1991		
0	64.6±12.2	64.6±12.2	49.6± 5.8	49.6± 5.8
3	52.3± 2.5	50.4± 7.4	25.9± 5.2	46.7±10.2
9	73.3± 2.9	57.6± 9.0	38.9± 4.4	50.6± 4.3
15	50.7± 4.9	49.9± 1.9	41.8± 5.1	35.5± 5.0
21	52.9± 2.5		41.1± 6.6	

Larval survival of both species was significantly reduced by larval densities of more than 3 grubs per microplot during 1991/92 ($P < 0.05$) (Figure 1). Significant reductions in survival related to initial grub density also were determined during 1989/90 for *C. lurida* on fescue ($P = 0.02$). The fungal pathogen *Metarhizium anisopliae* was observed in larval cadavers recovered from microplots during 1991/1992 and was likely a contributory factor in the density related mortality experienced during this study.

CONCLUSIONS

The two grub species studied responded differently in terms of growth and survival depending upon turfgrass host species in this field evaluation. In general Tifway bermudagrass enhanced larval survival, while KY-31 tall fescue favored third instar larval growth. Possibly greater larval weights would result in larger adults with greater fecundity although this was not tested. Results of this study indicate that turf irrigated during critical periods can tolerate grub densities well in excess of established thresholds.

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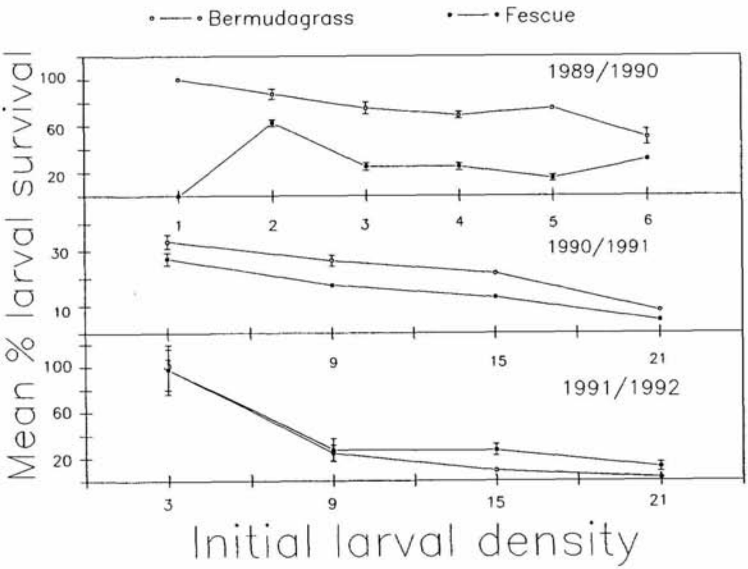

Fig. 1. Influence of initial infestation level on larval survival in KY-31 fescue and Tifway bermudagrass during 1989, 1990, and 1991.