1997
RUTGERS
Turfgrass Proceedings

THE NEW JERSEY TURFGRASS ASSOCIATION

In Cooperation With

RUTGERS COOPERATIVE EXTENSION
NEW JERSEY AGRICULTURAL EXPERIMENT STATION
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
NEW BRUNSWICK

1997 RUTGERS TURFGRASS PROCEEDINGS

of the

New Jersey Turfgrass Expo
December 9-11, 1997
Trump Taj Mahal
Atlantic City, New Jersey

The Rutgers Turfgrass Proceedings is published yearly by the Rutgers Center for Turfgrass Science, Rutgers Cooperative Extension, and the New Jersey Agricultural Experiment Station, Cook College, Rutgers University in cooperation with the New Jersey Turfgrass Association. The purpose of this document is to provide a forum for the dissemination of information and the exchange of ideas and knowledge. The proceedings provide turfgrass managers, research scientists, extension specialists, and industry personnel with opportunities to communicate with co-workers. Through this forum, these professionals also reach a more general audience, which includes the public. Articles appearing in these proceedings are divided into two sections.

The first section (white pages) includes lecture notes of papers presented at the 1997 New Jersey Turfgrass Expo. Publication of the New Jersey Turfgrass Expo Notes provides a readily available source of information covering a wide range of topics. The Expo Notes include technical and popular presentations of importance to the turfgrass industry.

The second section (green pages) includes technical research papers containing original research findings and reviews covering selected subjects in turfgrass science. The primary objective of these papers is to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

Special thanks are given to those who have submitted papers for this proceedings, to the New Jersey Turfgrass Association for financial assistance, and to those individuals who have provided support to the Rutgers Turf Research Program at Cook College - Rutgers, The State University of New Jersey.

Dr. Ann B. Gould, Editor
Dr. Bruce B. Clarke, Coordinator

DEVELOPING KENTUCKY BLUEGRASS CULTIVARS WITH IMPROVED RESISTANCE TO BILLBUGS

Jennifer Johnson-Cicalese, William A. Meyer, Melissa Mohr, Karen Plumley, and Thomas Molnar[1]

Considerable potential exists for the development of turfgrasses with improved resistance to insect pests. Grasses possess a wide array of defenses against insects, including morphological and biochemical defenses of the plant and enhanced resistance associated with endophytic symbionts. Kentucky bluegrass (*Poa pratensis* L.) does not have endophyte-enhanced resistance, but it does possess genetic variability in its resistance to insect pests. One objective of the Rutgers turfgrass breeding program is to develop Kentucky bluegrass cultivars with improved resistance to billbugs (*Sphenophorus* spp.; Coleoptera:Curculionidae), a serious turf pest.

In New Jersey, the four species of billbugs commonly found on turf are the bluegrass (*S. parvulus*), hunting (*S. venatus*), uneven (*S. inaequalis*), and little (*S. minimus*) billbugs. The adults of these four species can be distinguished from each other by markings on their thorax. Adults have a long snout, are brown to black, and are 1/4 to 3/8 inch long. The grub-like larvae do most of the damage but can not be identified to species. Larvae are white with a brown head, 1/4 to 3/8 inch long when fully developed, and can be distinguished from white grubs by their lack of legs. Billbugs overwinter primarily as adults, become active as the weather warms up in the spring, and lay their eggs inside of grass stems and tillers during April to June. The larvae feed first within the stem, then move out and feed on the crown and the base of tillers. Most larvae pupate in late summer, emerge as adults soon after, and move to protected overwintering sites. Some billbugs overwinter as larvae.

Billbug damage is often mistaken for drought or disease injury, thus it is likely that the importance of this pest is underestimated. Damage appears as straw-colored patches of turf in mid to late summer, and can be diagnosed with the 'tug-test.' If clumps of dead turf break off easily at the crown when tugged on, and sawdust-like frass is visible in the hollowed-out stems, it is probably billbug damage. Probing turf for larvae will confirm the diagnosis. Billbugs will feed on most cool-season grasses, but are most common on bluegrass. Damaging levels of billbug populations often take a few years to develop, so monitoring for this insect can be especially useful for predicting problems. Adults can be monitored with pitfall traps or by watching for them along sidewalks on warm spring days. Larvae can be counted using cup-cutter samples.

Cultural practices can have a big impact on billbug damage. A healthy, vigorous, well maintained turf is often able to outgrow minor billbug infestations. In addition, billbug resistant and/or endophyte-infected cultivars should be included in seed mixtures when establishing new turf or overseeding. Several bluegrass cultivars with moderate resistance to billbugs are currently available and will be discussed in this paper. If control measures become necessary, treat in early spring after adults become active and before egg laying occurs, or target larvae after they emerge from stems, usually late June. A degree-day (dd) model has been developed to help time applications (Watschke et al., 1995). Using the average method of calculation, a March 1 starting date, and a threshold temperature of

[1] Post-Doctoral Research Associate, Research Professor, Soils and Plants Technician, Research Scientist, and Assistant Research Scientist, respectively, New Jersey Agricultural Experiment Station, Cook College, Rutgers, The State University of New Jersey, New Brunswick, NJ 08901.

50°, first adult activity should occur between 280 and 322 dd_{base50} and 30% adult activity between 560 and 624 dd. This is the last date at which adult insecticide applications will effectively prevent females from laying eggs. Larvae will emerge from stems at 925 to 1035 dd, thus larval control should be applied at this time. Significant damage can be predicted to occur at 1330 to 1485 dd. A number of insecticides are labeled for billbug control, and several entomopathogenic nematode products may also be effective.

Differences in resistance to billbugs among Kentucky bluegrasses have been recognized for a number of years. Researchers in New Jersey and Nebraska have studied this resistance and a number of resistance mechanisms have been suggested (Ahmad and Funk, 1983; Bruneau et al., 1987; Johnson-Cicalese et al., 1989). Resistance mechanisms are generally divided into three categories: antixenosis (plant is an unsuitable host), antibiosis (plant adversely affects the biology of insect), and tolerance (plant tolerates insect feeding without showing damage). In bluegrass, all three mechanisms may be involved; female billbugs may avoid narrow-leafed bluegrasses for egg laying (antixenosis), some billbug resistant cultivars have tougher leaf tissue (antibiosis), and aggressive or dense cultivars can outgrow or mask damage (tolerance). In addition, recent trials suggest an association between billbug resistance and heat and drought tolerance (Bonos and Smith, 1994). It is likely that different cultivars rely on different strategies; for example, some narrow-leafed and wide-leafed cultivars have exhibited good resistance to billbugs.

Understanding the mechanisms of resistance can be useful in a breeding program because it is often easier to screen for a characteristic that enhances insect resistance than it is to subject each selection to insect feeding trials. We are currently evaluating the concentration of several plant compounds in both resistant and susceptible bluegrasses to determine whether an association exists between billbug resistance and plant chemistry. We are also working on a more effective rearing method to more easily facilitate laboratory trials with billbugs. It is still imperative, however, to evaluate turf trials under natural infestations. In this paper, results from eight natural billbug infestations in six bluegrass trials are presented.

PROCEDURES

Six trials were established at the research facilities at North Brunswick or Adelphia, New Jersey in September 1986, 1990, 1993, 1994, and 1995. The 1990 and 1995 trials contained the entries from the NTEP-sponsored 1990 and 1995 Medium-High Maintenance National Tests. All plots were 3 X 5 ft, seeded at a rate of 2.2 lbs/1000 ft^2, and arranged in a randomized complete block design with three replications. Total nitrogen applied and mowing height on the year each trial was rated for billbug damage are presented in Table 1. Weeds were controlled with yearly applications of DCPA or bensulide, and 2,4-D and dicamba. No other pesticides were applied. Soils were moderately fertile and well-drained, and pH was maintained between 6.0 and 6.5. Tests were irrigated during establishment and also when needed to avoid severe drought stress. The 1994 Low Maintenance Test was irrigated only during establishment.

When natural infestations of billbugs occurred, each trial was rated for billbug damage using a 1 to 9 scale, where 9 = no billbug damage, 5 = appx. 50% of plot with damage, and 1 = entire plot damaged. Data were subjected to analysis of variance and means were separated using the least significant difference test (LSD).

RESULTS AND DISCUSSION

A wide range in billbug damage was found among cultivars and selections evaluated (Tables 2 and 4). Entries ranged from resistant to highly susceptible. Because many entries were planted in more than one trial, we were able to evaluate their performance during multiple billbug infestations. The severity of billbug damage, however, varied considerably between trials. Mean billbug ratings ranged from 3.1 to 7.8 (Table 2).

The 1986 Trial suffered the most severe billbug infestation, but only a few of the entries were commercial cultivars. Data obtained in 1991 from the 1990 trial is of limited value because the level of infestation was low, and the ratings correlate poorly with ratings from other trials (Table 3). In 1995, only a subset of 33 cultivars in the 1990 Trial were rated for billbugs. However, the 1997 data from the 1993 Trial is probably the most useful because a heavy billbug infestation occurred and many commercial cultivars were evaluated.

The degree to which sets of ratings correlate with one another can also indicate the accuracy of the data, and the consistency with which cultivars react to billbug feeding. A number of highly significant positive correlations were found between ratings (Table 3).

To facilitate comparisons between trials, cultivars in each rating were divided into four categories: resistant, moderately resistant, moderately susceptible, and susceptible (Table 2). For example, in the 1986 Trial (mean rating of 3.1), a cultivar was considered resistant if it had a rating of 9.0 through 5.5; moderately resistant: 5.4 to 4.0; moderately susceptible: 3.9 to 2.5; and susceptible: 2.4 to 1.0. In the 1990 Trial (mean rating of 7.8), cultivars were considered resistant if the rating was 9.0 to 8.2; moderately resistant: 8.1 to 7.0; moderately susceptible: 6.9 to 5.7; and susceptible: 5.6 to 3.3. Using this rating system, Kentucky bluegrass types and individual cultivars were given an overall ranking for susceptibility to billbugs.

In Table 2, cultivars and selections are grouped according to bluegrass type, and the types are ranked according to their overall resistance to billbugs. Each bluegrass type consists of cultivars with similar characteristics that influence bluegrass performance and sometimes billbug resistance (Bara et al., 1994; Bonos and Smith, 1994). For example, the Common types are thought to exhibit better resistance to billbugs due to natural selection in old pastures of the Midwest, where billbugs have long been a problem. In these trials, the Common types were most resistant to billbugs. Common types generally have fine leaves and are susceptible to leafspot, two factors that may deter oviposition. The Mid-Atlantic and Compact types closely followed the Common types in overall level of resistance. Most Mid-Atlantic types are naturalized selections from the mid-Atlantic states and have extensive root and rhizome growth and good tolerance to summer stresses. These are characteristics that enhance resistance to billbugs and aid in recovery from billbug damage. The Compact types varied in their susceptibility to billbugs; the dense growth of these cultivars may make billbug feeding less visible. Bellevue cultivars were least resistant to billbugs.

Within each bluegrass type, a range in billbug resistance was evident. In Table 2, entries are ranked from most resistant to most susceptible within each bluegrass type. Cultivars that consistently showed good resistant included Eagleton, Wabash, Midnight, Ram I, Wildwood, Unique, and Washington. Susceptible cultivars included Broadway, Georgetown, Canterbury, Classic, and Nassau.

Table 4 lists cultivars and selections from the 1995 Trial that were not included in Table 2. A wide range in amount of billbug damage was evident. Additional data is needed for these entries, however, before their relative resistance can be accurately determined. The cultivar with the least damage, Cache, is a Common type (Table 4) and has shown resistance in other trials (data not shown).

As we continue to learn more about resistance and billbugs, it should be possible to make further improvements in the resistance of Kentucky bluegrass cultivars. A number of cultivars with improved resistance are available to consumers and should be included in seed mixtures or blends, especially in areas where billbugs have been a problem.

ACKNOWLEDGMENTS

New Jersey Agricultural Experiment Station Publication No. E-12264-5-98. This work was conducted as part of NJAES Project No. 12264, supported by the New Jersey Agricultural Experiment Station, State, and Hatch Act funds, Rutgers' Center for Turfgrass Science, other grants, and gifts. Additional support was received from the United States Golf Association - Golf Course Superintendents Association of America Research Fund and the New Jersey Turfgrass Association.

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Table 1. Year turf trials were established and their location, dates evaluated for billbug damage, and maintenance during year of evaluation.

Trial	Dates evaluated	Mowing height[1]	Nitrogen[2]
1986 North Brunswick	Aug. 3 and 5, 1991	2.0	1.7
1990 North Brunswick	July 25, 1991	1.5	4.8
(includes NTEP Test)	July 27, 1995	1.5	2.8
1993 Adelphia	July 25, 1996	1.5	2.1
	July 25, 1997	1.5	3.3
1994 Adelphia (Low Maintenance)	July 20, 1996	2.5	0.0
1994 Adelphia	July 17, 1997	1.5	2.8
1995 Adelphia (includes NTEP Test)	July 17,1997	1.5	5.2

[1]Mowing height in inches.
[2]Annual nitrogen applied (lbs/1000 ft^2).

Table 2. Resistance of Kentucky bluegrass cultivars and selections to billbugs in New Jersey turfgrass trials.

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
COMMON									
Pomeroy	Res.	.	.	.	7.7	6.0	.	.	.
Cache	Res.	4.3[4]	8.7	.	.	.	.	.	8.4
H86-811 MC 13	Res.	4.5[4]	8.8	.	.	.	.	.	.
South Dakota Cert.	Res.	.	8.7	.	.	.	.	.	7.0
S-21	Mod. res.	.	8.3	.	8.3	7.0	6.3	5.7	7.0
Kenblue	Mod. res.	.	8.3	5.5					7.9
Huntsville	Mod. res.	.	8.7	.	8.0	5.7	5.7	5.7	6.0
H86-783 Roselawn	Mod. res.	5.0[4]	8.0	.	.	.	.	.	.
Alene	Mod. susc.	1.7	9.0	.	.	.	.	.	.
MIDATLANTIC									
A84-563 Vals. Park	Res.	.	9.0	7.5	.	.	.	.	.
H86-1185 Pa Turf Type	Res.	8.0[4]	9.0	.	.	.	.	.	.
H86-1051 Pa Turf Type	Res.	5.5[4]	8.7	.	.	.	.	.	.
Wabash	Res.	.	9.0	8.7	8.3	6.0	.	.	.
SR 2000	Res.	.	8.3	8.0	.	.	.	.	6.0
A82-1167 Patterson Park	Res.	4.5	9.0	.	7.2	6.5	.	.	.
Eagleton	Res.	.	9.0	8.0	.	.	.	6.7	7.0
BM-3 PST	Res.	.	8.3	6.3	.	.	.	.	.
H86-746 Beth Israel Cem	Res.	4.0[4]	9.0	.	.	.	.	.	.
H86-894 Muddy Park	Mod. res.	4.5[4]	7.7	.	.	.	.	.	.

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
MIDATLANTIC (continued)									
Bel 21	Mod. res.	.	8.3	.	.	.	5.7	6.0	5.9
Preakness	Mod. res.	.	8.3	6.3	.	.	.	5.8	5.9
Livingston	Mod. res.	.	8.3	7.3	.	.	6.3	5.0	5.7
A84-837 For. Hills A	Mod. susc.	.	8.3	.	.	.	5.3	4.7	.
Monopoly	Mod. susc.	.	7.7	7.3	.	.	.	.	4.0
H86-749 NB Cem	Mod. susc.	3.0[4]	8.7	.	.	.	5.6	4.0	.
RSP	Mod. susc.	.	.	.	.	.	6.2	4.9	.
A84-587 Balt City	Mod. susc.	.	9.0	6.0	.	.	5.0	4.3	3.3
COMPACT									
Midnight	Res.	.	8.3	8.0	8.3	6.3	7.7	7.7	7.7
Barsweet	Res.	.	8.3	8.7	.	.	.	.	.
Ram I	Res.	.	8.0	.	7.7	7.7	7.0	7.3	6.7
Alpine	Res.	.	8.3	6.7	.	.	.	.	7.7
Wildwood	Res.	.	.	.	6.7	7.3	6.0	8.0	8.0
Blacksburg	Res.	.	8.0	8.3	.	.	7.0	7.0	7.3
ZPS-2183	Res.	.	.	.	.	.	.	6.6	7.7
Indigo	Res.	3.1	9.0	8.3	.	.	.	.	7.4
Unique	Mod. res.	.	8.3	7.7	8.7	5.3	5.7	6.8	6.0
A83-70 A25xSyds	Mod. res.	.	.	.	6.7	5.3	6.3	6.3	.

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
COMPACT (continued)									
America	Mod. res.	.	7.7	.	.	.	6.3	6.7	6.3
Glade	Mod. res.	.	7.7	6.0	7.7	7.3	5.3	6.0	6.7
Conni	Mod. res.	.	6.3	5.3	.	.	.	.	7.3
Platini	Mod. res.	.	7.3	6.7	.	.	.	.	5.0
Able I	Mod. susc.	.	6.3	6.7	.	.	.	.	.
Trampas	Mod. susc.	.	7.7	6.0	.	.	.	.	.
Eva	Mod. susc.	.	8.0	6.0	.	.	.	.	.
Apex	Mod. susc.	.	7.0	5.7	5.3	4.3	6.0	7.7	.
Amazon	Mod. susc.	.	6.7	6.0	7.0	4.3	5.7	6.7	5.7
ISD-3 PST	Mod. susc.	.	8.0	4.7	.	.	.	.	.
Nugget	Mod. susc.	.	6.0	3.7	.	.	.	.	6.7
CHERI									
Cheri	Mod. res.	.	7.0	.	6.3	5.7	6.7	7.3	7.3
Cobalt	Mod. res.	.	7.0	.	.	.	.	.	6.0
A82-1095 HF II	Mod. susc.	.	8.3	.	5.0	3.7	6.1	6.8	7.0

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
AGGRESSIVE									
Princeton P-105	Mod. res.	.	.	.	7.2	6.1	5.5	7.9	7.3
Princeton P-104	Mod. res.	.	8.0	.	8.0	5.0	5.7	7.3	7.0
Limousine	Mod. res.	.	5.7	7.0	6.7	5.0	6.7	6.0	5.8
A-34	Mod. susc.	.	6.7	.	.	.	5.3	6.0	.
Touchdown	Mod. susc.	.	6.7	4.7	.	.	.	.	7.4
CELA									
Eclipse	Mod. res.	.	8.7	.	7.7	5.3	5.7	7.0	6.7
Adelphi	Mod. res.	.	7.7	7.3	7.9	4.5	6.3	6.3	.
Challenger	Mod. res.	.	8.0	.	.	.	.	.	7.0
Aspen	Mod. res.	.	8.0	.	.	.	5.3	7.0	.
Liberty	Mod. susc.	.	7.0	.	.	.	4.7	5.0	4.7
JULIA									
Caliber	Mod. res.	.	8.3	.	.	.	.	.	4.9
Julia	Mod. res.	.	8.2	.	7.3	6.0	5.3	5.3	4.7
BVMG									
Raven	Res.	.	8.3	.	.	.	.	.	6.0
Crest	Res.	.	8.7	.	.	.	.	.	7.0
Marquis	Res.	.	8.7	.	.	.	.	.	6.7
Kelly	Mod. res.	.	8.7	.	.	.	5.3	7.3	.
Merit	Mod. res.	.	8.3	.	.	.	5.7	6.7	.

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
BVMG (continued)									
Fortuna	Mod. res.	.	7.7	.	.	.	.	.	6.7
Abbey	Mod. susc.	.	7.7	.	.	.	.	.	3.7
BlueStar	Mod. susc.	.	8.0	.	.	.	.	.	3.7
Baron	Mod. susc.	2.3	8.7	.	5.7	3.7	5.0	5.3	5.2
Nassau	Mod. susc.	2.3	8.7	.	5.7	5.0	5.0	4.3	3.3
OTHER									
A90-327 A25xBG	Res.	.	.	.	9.0	7.0	7.5	7.5	.
A84-123 Adelphi der	Res.	.	.	.	8.3	6.7	.	.	.
A85-301 A20-6A OP	Res.	.	.	.	8.3	6.3	.	.	.
A91-507 Del	Res.	.	.	.	7.7	6.3	.	.	.
Ascot	Res.	.	8.7	.	.	.	.	.	7.7
SR A82-2005	Res.	.	.	.	.	.	7.3	7.3	.
A83-876	Res.	.	.	.	8.3	6.7	6.3	7.3	.
Washington	Res.	.	8.2	6.7	8.3	7.7	6.7	7.7	7.3
H86-1019 A25xBG	Res.	6.5[4]	.	.	.	.	7.5	6.0	.
Belturf	Res.	.	.	.	9.0	7.3	6.5	6.6	.

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
OTHER (continued)									
A91-706 Ewing 5 der	Res.	.	.	.	8.0	6.3	6.3	6.7	.
H87-199 Patch 54	Res.	.	.	.	7.0	6.7	.	.	.
A84-619 A25xTD	Res.	.	.	.	6.7	6.7	.	.	.
J-308	Res.	.	.	.	6.7	6.3	.	.	.
A91-609 Julia OP	Res.	.	.	.	7.7	5.3	.	.	.
H86-247 A20xBG late	Res.	4.7[4]	8.7	.	.	.	.	.	.
Cardiff	Res.	.	8.3	.	.	.	.	.	6.3
Nimbus	Mod. res.	.	.	.	.	.	5.7	7.3	6.7
J-327	Mod. res.	.	9.0	.	6.7	5.3	.	.	.
SRX 2109 (A84-1110)	Mod. res.	.	.	.	6.9	5.4	6.6	7.3	.
Rita	Mod. res.	.	.	.	7.2	5.4	6.3	6.3	7.4
A88-1239(A25xEO)xSyd	Mod. res.	.	7.3	.	7.7	6.0	6.0	6.7	.
A88-90 A25xBG	Mod. res.	.	.	.	7.0	6.0	.	.	.
Bartitia	Mod. res.	.	6.0	.	.	.	.	.	7.7
NJ-1190	Mod. res.	.	.	.	.	.	.	6.3	6.0
H86-550 Cascade	Mod. res.	4.0[4]	8.0	.	.	.	.	.	.
H86-920 PlexBTE	Mod. res.	3.5[4]	8.0	.	.	.	5.7	6.0	7.3
A82-570	Mod. res.	.	8.3	.	.	.	.	5.0	.
A91-430 J Moore	Mod. res.	.	.	.	.	.	6.0	6.0	6.7
NuStar	Mod. res.	.	8.0	.	5.3	6.3	6.7	6.7	6.7

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
OTHER (continued)									
Plush	Mod. res.	.	.	.	7.0	4.7	5.3	6.0	8.0
A91-621 (LTP-621)	Mod. res.	.	.	.	7.7	4.7	5.5	5.8	.
A91-376 Rt 301	Mod. res.	.	.	.	8.0	7.0	5.5	3.2	.
A88-1044 A25xEO FD	Mod. res.	.	8.7	.	.	.	5.3	5.7	.
A82-1272 Trenton CC	Mod. res.	2.0	8.3	.	6.3	5.7	5.9	6.0	.
A88-199 Tennant Cem	Mod. res.	.	8.0	.	7.5	4.7	.	.	.
A90-1328 Rahway	Mod. res.	.	.	.	6.7	2.3	.	.	7.3
A91-458 Cooper R.	Mod. res.	.	.	.	.	.	6.3	4.7	7.3
H90-1149	Mod. res.	.	.	.	7.2	3.7	6.0	6.7	7.0
H86-788 J&J	Mod. res.	1.0[4]	6.3	.	.	.	6.2	7.3	6.7
A88-744 A25xEO	Mod. susc.	.	9.0	.	.	.	6.5	5.0	3.3
H86-190 Rt70 OP	Mod. susc.	2.5[4]	7.7	.	6.0	5.7	.	.	.
Dragon	Mod. susc.	.	9.0	.	7.5	2.7	.	.	4.9
H86-681 A25xEO	Mod. susc.	3.0[4]	7.0	.	.	.	.	.	.
H86-669 U of Ky A	Mod. susc.	1.5[4]	9.0	.	.	.	.	.	.
H86-966 Ky Horse P.	Mod. susc.	1.5[4]	8.7	.	.	.	.	.	.
SR 2100	Mod. susc.	.	9.0	.	.	.	.	.	4.3
Allure	Mod. susc.	.	6.7	.	.	.	.	.	6.7
Coventry	Mod. susc.	.	6.3	.	.	.	.	.	6.7
A91-624 (A25xEO)xSyds	Mod. susc.	.	.	.	.	.	.	7.0	5.5

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 trial 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
OTHER (continued)									
A89-255 A84-591 GA448	Mod. susc.	.	.	.	6.3	5.0	6.0	5.7	.
A84-562 Vals. Park	Mod. susc.	.	.	.	8.0	4.3	5.7	4.7	.
Merion	Mod. susc.	.	.	.	6.3	4.0	.	.	7.0
Shamrock	Mod. susc.	.	6.3	.	6.9	3.4	5.7	5.7	7.2
Fylking	Mod. susc.	.	5.0	.	6.3	2.3	5.7	7.0	7.3
A91-628(A25xEO)xSyds der	Mod. susc.	.	.	.	.	.	5.7	4.7	7.0
A91-630(A25xEO)xSyds der	Mod. susc.	.	.	.	6.7	4.3	5.0	5.3	.
A82-1271 Trenton CC	Mod. susc.	1.5	.	.	.	.	5.3	6.9	6.2
H87-415 A20-6A OP	Mod. susc.	.	8.3	.	.	.	4.7	4.7	.
Sydsport	Mod. susc.	.	.	.	3.7	4.7	5.3	6.3	5.7
Penn Pro	Mod. susc.	.	5.0	.	6.7	3.3	5.0	7.0	.
H86-766 1976 Bent	Mod. susc.	2.5[4]	6.7	.	.	.	.	.	.
H86-893 Princeton	Mod. susc.	1.8[4]	7.7	.	.	.	.	.	.
H86-669 U of Ky B	Mod. susc.	1.5[4]	8.0	.	.	.	.	.	.
H86-690	Mod. susc.	1.0[4]	.	.	.	.	.	.	6.4
Nutop	Mod. susc.	.	6.7	5.7	.	.	.	.	.
A91-625(A25xEO)xSyds der	Mod. susc.	.	.	.	.	.	5.3	5.3	4.7
A91-626(A25xEO)xSyds der	Mod. susc.	.	.	.	.	.	5.3	5.3	.
A88-98 P57xBaron	Mod. susc.	.	.	.	6.0	3.0	5.3	7.0	.
A91-426 J Moore	Mod. susc.	.	.	.	.	.	5.3	5.7	5.0

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
OTHER (continued)									
NuBlue	Mod. susc.	.	7.3	.	5.7	4.0	4.3	5.7	.
1757	Mod. susc.	.	7.7	.	6.0	3.7	5.3	4.7	.
Belmont	Mod. susc.	.	8.0	.	5.0	3.7	4.7	5.7	.
H86-697	Mod. susc.	1.0[4]	3.5	.	5.7	3.0	5.0	5.0	6.3
H86-930 Tenn 140	Susc.	2.0[4]	7.7	.	.	.	4.3	4.3	.
A91-725(A25xEO)xSyds der	Susc.	.	.	.	.	.	4.9	5.7	.
H90-205 A84-587 Balt City	Susc.	.	.	.	5.8	4.2	.	.	.
Miranda	Susc.	2.7	3.7	.	.	.	.	.	.
LTP-620	Susc.	.	.	.	.	.	.	4.9	4.8
H90-1121 Rt 130	Susc.	.	.	.	.	.	5.3	4.7	.
A90-1128 P57xBaron	Susc.	.	.	.	.	.	.	4.5	5.3
Canterbury	Susc.	.	.	.	.	.	5.3	4.0	3.7
A90-1070 A25xEO	Susc.	.	.	.	6.3	2.7	.	.	4.3
H86-983 NB Cem	Susc.	2.3[4]	.	.	.	.	.	3.7	.
Broadway	Susc.	.	3.3	2.7	.	.	.	.	.

Table 2 (continued).

Cultivar or Selection	Resistance[2]	Billbug damage rating[1] 1986 --trial-- 1991	-----1990 trial----- 1991	1995	-----1993 trial----- 1996	1997	1994 Low maint. trial[3] 1996	1994 trial 1997	1995 trial 1997
BELLEVUE									
Baronie	Mod. susc.	.	8.3	.	.	.	.	.	3.5
Haga	Mod. susc.	.	9.0	.	.	.			4.3
Freedom	Mod. susc.	.	8.0	.	7.3	2.7	6.0	5.0	3.3
Suffolk	Mod. susc.	.	8.3	.	6.0	2.3	5.0	5.0	3.7
J13-152	Mod. susc.	.	8.7	.	5.7	3.3	.	.	.
H87-104 Pat Pk	Mod. susc.	.	8.3	.	6.0	2.3	4.9	4.7	.
Trenton	Mod. susc.	.	8.3	.	6.0	3.3	3.7	4.7	.
Classic	Mod. susc.	.	8.7	.	5.7	3.7	5.0	4.3	3.7
J11-94	Mod. susc.	.	8.0	.	5.3	3.3	.	.	.
J34-99	Mod. susc.	.	7.7	.	5.7	3.0	.	.	.
Rugby	Susc.	.	.	.	6.0	2.7	4.7	5.0	.
Georgetown	Susc.	.	8.7	4.3	5.7	3.7	3.7	3.7	.
	LSD at 5% =	1.7	1.9	1.7	2.0	1.9	1.5	1.3	1.7
	Mean	3.1	7.8	6.5	6.9	4.9	5.7	5.9	6.1

[1] Rating scale of 9 to 1, where 9=no damage.
[2] Res. = resistant; Mod. res. = moderately resistant; Mod. susc. = moderately susceptible; Susc. = susceptible. Based on mean performance in all trials.
[3] Low maintenance.
[4] Rating of one plot only, all other values are means of three plots.

Table 3. Correlations between billbug damage ratings taken during eight infestations in six bluegrass trials.

		----------1990 trial----------		----------1993 trial----------		1994 Low maint. trial	1994 trial	1995 trial
		1991data	1995 data	1996 data	1997 data	1996 data	1997 data	1997data
1986 Trial	*r* =	0.36	---	0.85*	0.77	0.69*	-0.03	0.11
1991 data	*P* >	0.06	---	0.03	0.07	0.03	0.92	0.80
	n =	28	1	6	6	10	11	8
1990 Trial			0.62*	0.16	0.26	-0.03	-0.23	-0.27
1991 data			0.00	0.30	0.09	0.83	0.09	0.04
			33	43	43	52	55	62
1990 Trial				0.78*	0.40	0.84*	0.53*	-0.03
1995 data				0.01	0.25	0.00	0.05	0.91
				10	10	12	14	20
1993 Trial					0.58*	0.51*	0.28*	0.26
1996 data					0.00	0.00	0.05	0.14
					75	53	53	33
1993 Trial						0.61*	0.42*	0.41*
1997 data						0.00	0.00	0.02
						53	53	33
1994 LM Trial							0.55*	0.48*
1996 data							0.00	0.00
							85	46
1994 Trial								0.71*
1997 data								0.00
								53

*Iindicates a significant positive correlation between the two sets of data.

Table 4. Billbug damage ratings of Kentucky bluegrass cultivars and selections in a trial established September 1995 at Adelphia, NJ.[1]

	Cultivar or selection	Billbug damage[2] July 1997
1	93-864-6 C-74 OP (H94-301)	8.3
2	A91-749 N Cooper River YT	8.3
3	PST-P46	8.3
4	93KB 5	8.0
5	PST-B2-42	8.0
6	BAR VB 3115B	7.9
7	BAR VB 6820	7.9
8	1595-7 P.T. OP	7.7
9	2549 H92-558 Julia der	7.7
10	2559 A93-420 Julia der	7.7
11	4253-12 803-8 C-74 OP der	7.7
12	860-3 C-74 OP	7.7
13	93-863-3 C-74 OP	7.7
14	A90-924 Julia der	7.7
15	A93-417 Julia der	7.7
16	A93-421 Julia der	7.7
17	AG 508 PSW	7.7
18	H92-612 A82-204 VT	7.7
19	Moonlight	7.7
20	SR 2109	7.7
21	Total Eclipse	7.7
22	A93-31 C-74	7.5
23	Jefferson	7.4
24	2565 A93-453 Julia der	7.3
25	92-123-9 A81-1372 der	7.3
26	92-3154-3 P.T. OP (Supreme)	7.3
27	92-78 RSP Typ	7.3
28	94-128-9 C-74 OP	7.3
29	A91-639 Forest Hill der	7.3
30	Absolute	7.3

Table 4 (continued).

	Cultivar or selection	Billbug damage[1] July 1997
31	AG 496 PSW	7.3
32	Arcadia	7.3
33	Bronco	7.3
34	J-1576	7.3
35	NuGlade	7.3
36	Odyssey	7.3
37	Quantum Leap	7.3
38	ZPS-2572	7.3
39	A90-287 Julia der	7.2
40	BA 81-058	7.0
42	D3WN 763	7.0
43	NJ-GD	7.0
44	PST-BO-141	7.0
45	Rugby II	7.0
46	1585-3 P.T. OP	6.7
47	92-1492-5 A82-1272 OP	6.7
48	92-2248-2 C-74 OP	6.7
49	93-860-6 C-74 OP	6.7
50	Award	6.7
51	BA 81-270	6.7
52	H90-710 A84-605	6.7
53	NJ-54	6.7
54	NTT 683	6.7
55	Pick 8-15-94W	6.7
56	SRX 2205	6.7
57	Blue Chip	6.3
58	Goldrush	6.3
59	KBGJB91-B Cascade	6.3
60	MED-1580	6.3
61	Misty	6.3
62	Pick 247 PSW	6.3
63	PST-B9-196	6.3
64	Rambo	6.3
65	93-860-2 C-74 OP	6.0

Table 4 (continued).

	Cultivar or selection	Billbug damage[1] July 1997
66	BA 70-060	6.0
67	BA 81-220	6.0
68	Blackstone	6.0
69	Chateau	6.0
70	Chicago	6.0
71	JC91 L II	6.0
72	LKB-95	6.0
73	LTP-621	6.0
74	PST-A7-245A	6.0
75	Seabring	6.0
76	Sodnet	6.0
77	Lipoa	5.9
78	93-1955-4 A83-876 der	5.7
79	BA 77-102	5.7
80	Compact	5.7
81	H92-109 A83-876 P154 OP	5.7
82	J-1555	5.7
83	Pepaya	5.7
84	Pick 151	5.7
85	PST-B3-180	5.7
86	93KB 8	5.3
87	BA 81-227	5.3
88	Explorer	5.3
89	PST-BO-165	5.3
90	Wx5 955-2	5.3
91	BA 73-373	5.0
92	Exp# 1589	5.0
93	HV 130	5.0
94	Pick 2 PSW	5.0
95	Pick 3 PSW	5.0
96	Pick 4 PSW	5.0
97	ZPS-309	5.0
98	BAR VB 233	4.9
99	VB 16015	4.9
100	BA 75-103	4.7

Table 4 (continued).

	Cultivar or selection	Billbug damage[1] July 1997
101	BA 75-490	4.7
102	BA 76-197	4.7
103	BA 81-113	4.7
104	H90-529 H86-749 NB Cem	4.7
105	93KB 9	4.5
106	H90-315 Muddy PK	4.5
107	93KB 2	4.3
108	93KB 4	4.3
109	BA 75-173	4.3
110	Pick 855	4.3
111	BAR VB 5649	4.2
112	Baruzo	4.0
113	HV 242	3.7
114	BH 95-199	3.3
115	KB-02-04x35 Cascade	3.3
116	Pick Vat	3.3
117	93 KB1	3.0
118	KB-02-06Ax23 Cascade	2.7
119	PTE Cascade	2.7
	LSD at 5% =	1.7
	Mean	6.1

[1] This table includes only those entries not listed in Table 1.
[2] Billbug damage rating: 9 to 1, where 9 = no damage.