

Now you can control grubs preventatively or curatively. With a single application. Only with new MACH 2™ Turf Insecticide.

MACH 2 is a powerful killer with a new chemistry that accelerates the molting process of target insects.

Just hours after ingesting MACH 2, the insect stops feeding. Then it dies beneath the surface in 2 to 3 weeks. It's that simple.

With MACH 2™ Turf Insecticide, you'll kill target enemy insects all season long. Grubs. Cutworms. Armyworms. Sod webworms. Plus, odorless MACH 2™ is easy to apply.

You don't even have to water it in immediately.

So don't let grubs control your grounds, or your schedule. Depend on MACH 2™ Turf Insecticide.

It's all you need to prevent or cure.

For more information or for the distributor nearest you, call 1-888-764-6432.

MACH 2™
TURF INSECTICIDE

**ALL YOU NEED
 TO PREVENT OR CURE.**

SOIL FEEDERS

BLACK TURFGRASS ATAENIUS (BTA)

aka: Black Fairway Beetle

scientific name: *Ataenius spretulus*

Similar species: Aphodius Beetle

FIELD KEYS

Hosts: bentgrass, annual bluegrass, ryegrass,

Site symptoms: Wilted turf in late spring to early summer that turns brown in small to large patches despite sufficient water. Wilted and brown leaves and crowns pull up easily from soil because of extensive root damage. Many small grubs may be visible on soil below removed turf.

Plant symptoms: Extensively damaged root structure at the plants' crown/root interface.

Site keys: A serious problem on golf tees, greens, and fairways and other sports turf sites and occasionally a problem on residential sites.

SPECIMEN ID

Immatures are very small to small white grubs with full grown 3rd instars reaching 1/8 inch. Adults are small bullet shaped, reddish brown to black, shiny beetles that reach 1/8 inch.

SCOUTING TIPS

At many locations BTA is a two generation pest, so in-season adults and all three instar stages can frequently be found together. Over-wintering adults fly to site and can be seen swarming over turf at dusk on a warm evening before they burrow into soil to lay eggs. Adults can be captured with either a sweep net or black-light traps. Third instar grub is the most damaging and can be found in great numbers peaking in late June and again in August. Grubs can be sampled with a cup cutter or similar plug removal device (down to 2 inch depth).

CONTROL STRATEGIES

Cultural: At sites where BTA has been a problem monitor for swarming adults on warm evenings in spring. Natural predators do not seem to adequately control BTA, and immature concentrations that exceed 30 grubs per square foot should get additional attention. Since over-wintering sites can be as much as a mile away and are often wooded areas, cleaning the local site of debris or leaf litter may not prove helpful.

Chemical: Grub concentration thresholds that start to show damage can vary widely from 30 to 100 per square foot. Managers should correlate populations with the appearance of damage to develop site specific treatment thresholds.

Note: MACH 2 can be applied in mid-May when BTA adults migrate to egg laying sites. MACH 2 residual activity will eliminate resulting grub populations.



GRUB



ADULTS

SPECIES ACTIVITY, BIOLOGY & LIFE CYCLE



Growth stages: egg - grub (three instars)* - pupa - adult*

* - treatable stages

Life cycle: one to two generations per year

Sequence: adult - egg - grub - pupa - adult

RASTER PATTERN

In the field, use a 10x magnification lens to view raster patterns.



DISTRIBUTION



■ Indigenous states

EUROPEAN CHAFER (EC)

scientific name: *Rhizotrogus majalis*

FIELD KEYS

Hosts: Most grass species

Site symptoms: Turf wilting under heat stress despite adequate available moisture. Wilted turf rapidly dies in irregular patches. Removing dead or wilted turf reveals grubs feeding at the soil-thatch interface.

Plant symptoms: Above-ground plant structure shows no obvious damage or other symptoms, however root system shows extensive damage at the soil-thatch interface from grub feeding.

Site keys: Any sunny location with adequate soil moisture and organic content, managed or unmanaged.

SPECIMEN ID

Immatures are six-legged white grubs with tan heads. Third instars can reach 1 inch when fully grown. Adults are slightly shiny chestnut brown colored, ½ inch-long beetles.

SCOUTING TIPS

Over-wintering third instar grubs become active as soon as the soil thaws and continue to feed until late spring. Actively feeding over-wintering third instars may produce severe turf damage by late spring or early summer during hot or dry springs. After pupation, adults emerge on mating flights for several hours after dusk when temperatures are greater than 66°F. Mating occurs in trees and several hundred beetles can be shaken from trees or caught in sweep nets at peak flight times. Grub sampling at vulnerable sites should begin three to four weeks after adults begin to appear in light traps. EC grubs are very active feeders often continuing feeding until the ground freezes and may resume during thaws in warmer winter periods.

CONTROL STRATEGIES

Cultural: Improve drainage at wet sites and manage turf for maximum root production. Maintain turf so thatch accumulation is kept to less than ½ inch.

Chemical: Once regular grub sampling indicates that the per square foot grub population has reached 8-10, consider making control applications to asymptomatic managed sites. Unmanaged sites as well as highly vulnerable managed sites may show damage once grubs populations reach 3-5 per square foot.



GRUB



ADULT

SPECIES ACTIVITY, BIOLOGY & LIFE CYCLE



Growth stages: egg - grub (three instars)* - pupa - adult

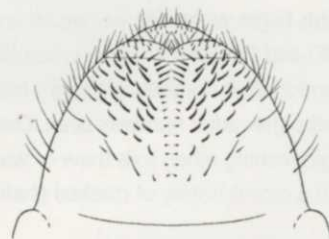
* - treatable stages

Life cycle: mostly a 1 year life cycle (multiple generations)

Sequence: grub - pupa - adult - egg - grub

RASTER PATTERN

In the field, use a 10x magnification lens to view raster patterns.



DISTRIBUTION



Indigenous states

SOIL FEEDERS

NORTHERN MASKED CHAFER (NMC)

SOUTHERN MASKED CHAFER (SMC)

scientific name: *Cyclocephala* spp.

FIELD KEYS

Hosts: Most grass species

Site symptoms: Turf wilting under heat stress despite adequate available moisture. Turf is unresponsive to water and fertilizer applications. Wilted turf turns off color and dies in irregular patches to large uniform areas. Removed dead or wilted turf reveals grubs feeding at soil-thatch interface down to 2-inch soil depth.

Plant symptoms: Above-ground plant structure shows no obvious damage or other symptoms. Root system shows extensive damage from the crown down to a 2-inch depth.

Site keys: Sunny locations with consistent soil moisture and higher organic content.

SPECIMEN ID

Immatures are typical six-legged white grubs with tan heads that range in size from $\frac{1}{8}$ inch for newly hatched first instars to 1 inch fully grown third instars. Adults are $\frac{3}{8}$ to $\frac{1}{2}$ inch-long yellow brown beetles with darker brown heads.

SCOUTING TIPS

Masked chafers have typical one year life cycles. Adult NMC flights begin when degree-day accumulations reach ~ 900 (base 50°F) and SMC flights begin when degree-days reach ~ 1000. Monitor adult numbers with light traps. Sample about three weeks after adult numbers peak. Overwintering 3rd instar grubs begin feeding when soils thaw or warm. Sample vulnerable sites with a recent history of masked chafers infestations in the spring.

CONTROL STRATEGIES

Cultural: NMC and SMC eggs are particularly susceptible to desiccation in drier soils, so where possible limit supplemental watering at vulnerable sites (to increase egg and first instar mortality) starting when adult flights peak. Increase drainage at wet sites and manage turf for maximum root production.

Chemical: 3rd instar masked chafer grubs often spend as much time feeding on dead organic matter as they do on grass roots. Damage threshold population densities can vary depending on turf vigor and moisture. Where no damage is visible, consider applications to asymptomatic when grub population samples are over 10 per square foot. At more vulnerable or low maintenance sites, applications may need to begin once grubs populations reach 6-8 per square foot.



SPECIES ACTIVITY, BIOLOGY & LIFE CYCLE



Growth stages: egg - grub (three instars)* - pupa - adult

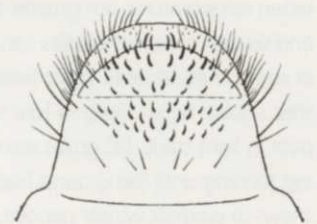
* - treatable stages

Life cycle: 1 year life cycle

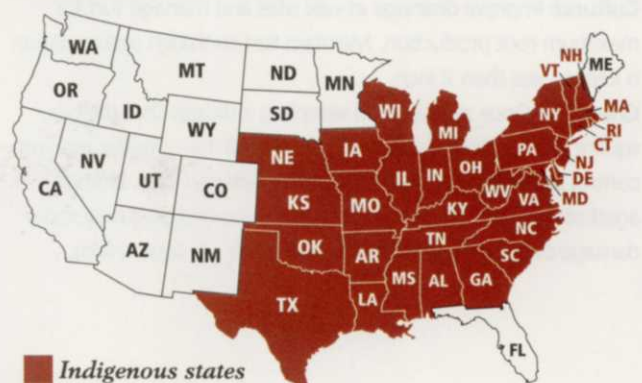
Sequence: grub - pupa - adult - egg - grub

RASTER PATTERN

In the field, use a 10x magnification hand lens to view raster patterns.



DISTRIBUTION



SOIL FEEDERS

GREEN JUNE BEETLE (GJB)

aka: Fig Eater

scientific name: *Cotinis nitida*

FIELD KEYS

Hosts: Most grass species

Site symptoms: Irregular turf areas die under heat or moisture stress from damage caused by disrupted roots or thinned thatch layers. Grubs borrow in soil leaving loose soil and anthill-like mounds 1½ to 2-inches high.

Plant symptoms: Above-ground plant structure shows no obvious damage or other symptoms, however root system may show extensive disruption from grub tunneling and burrowing activities.

Site keys: Locations with high soil organic content or where manure or compost has been used in site management or construction.

SPECIMEN ID

Immatures are short legged white grubs with tan heads that range in size from ¼ inch for newly hatched first instars to 2-inches for fully growth third instars. Adults are large, broad-bodied beetles (1 inch long and ½ inch wide) with iridescent green heads and mottled green and brown wing covers.

SCOUTING TIPS

GJB do not directly feed on grass roots, rather turf damage results from burrowing and tunneling activities of these large grubs. At night, the grubs emerge from their borrows and crawl on their backs (up to 65 feet per night) while looking for decaying organic matter on the soil surface to feed upon. Look for small mounds of soil at burrow entrances. Also their crawling activities often leave trails in sand, loose soil or on dew-covered surfaces. Adults can be captured in light traps or may be found feeding on sugary thin-skinned fruits such as figs, grapes and peaches. Begin grub scouting 3-4 weeks after adult emergence.

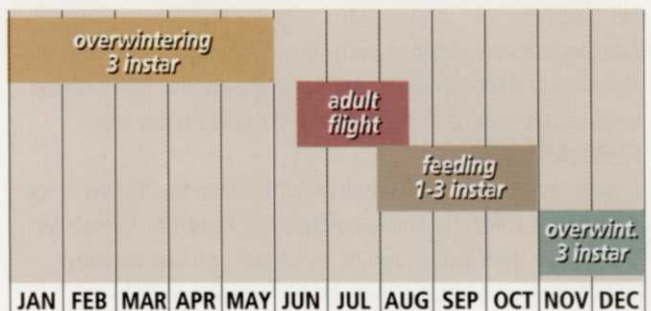
CONTROL STRATEGIES

Cultural: Monitor adult and larval populations as this pest tends to follow a 3 - 6 year damage cycle. Avoid using manures or composts in the management or construction of turf sites. Manage these sites for maximum plant recovery and overseed with stolen or rhizome producing grass species.

Chemical: Once grub scouting activities indicate per square foot grub population of 6-8 on tall cut turf, consider making control applications to infested sites. At more vulnerable sites or areas where their burrowing activities can disrupt site usage (golf and sports sites), applications may begin two weeks after adult emergence. Early applications also reduce the chance of large grubs surfacing and dying.



SPECIES ACTIVITY, BIOLOGY & LIFE CYCLE



Growth stages: egg - grub (three instars)* - pupa - adult*

* - treatable stages

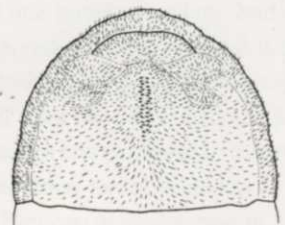
Life cycle: 1 year life cycle

grub - pupa - adult - egg - grub

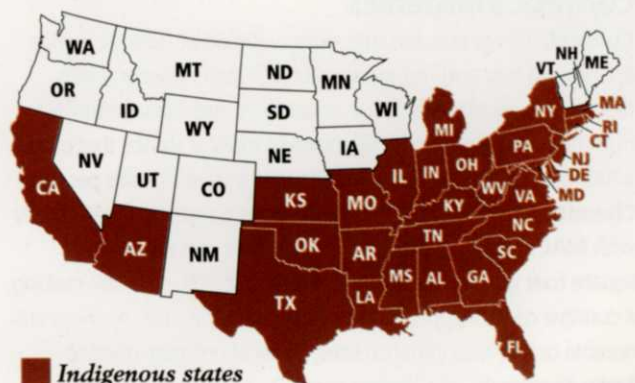
Sequence: grub - pupa - adult - egg - grub

RASTER PATTERN

In the field, use a 10x magnification hand lens to view raster patterns.



DISTRIBUTION



■ Indigenous states

SOIL FEEDERS

JAPANESE BEETLE

scientific name: *Popillia japonica*

FIELD KEYS

Hosts: Most grass species

Site symptoms: Turf wilting under heat stress despite adequate available moisture. Wilted turf dies in irregular patches. Removed dead or wilted turf reveals grubs feeding at soil - thatch interface down to 2-inch soil depth.

Plant symptoms: Above-ground plant structure shows no obvious damage or other symptoms. Root system shows much feeding damage from the crown down to a 2-inch depth.

Site keys: Sunny locations with consistent soil moisture and moderate soil temperatures and flowering shrubs, fruit-bearing trees, and vegetable or agriculture production in the area.

SPECIMEN ID

Immatures are six-legged white grubs with tan heads that range in size from ¼ inch for newly-hatched first instars to 1¼ inch for fully-grown third instars. Adults are ¾ to 1 inch beetles with metallic green heads and shiny bronze colored wing covers.



SPECIES ACTIVITY, BIOLOGY & LIFE CYCLE



Growth stages: egg - grub (three instars)* - pupa - adult*

* - treatable stages

Life cycle: 1 to 2 year life cycle

Sequence: grub - pupa - adult - egg - grub

SCOUTING TIPS

JB over-winters as a third instar grub at soil depths of two to six inches which resumes feeding in April and May, pupates, and emerges as an adult 30 days later. These voracious daylight-feeding adults reach maximum numbers on sunny days when temperatures are 70° - 95° F and humidity is low to moderate. Adult numbers can be monitored with lure attractants or with sweep nets at feeding sites on flowering shrubs, roses, or fruit-bearing trees. Grub sampling should begin 3-4 weeks after maximum adult numbers have been seen. JB larva are vulnerable to extremes of temperature and moisture, so in dry years sample in low or wet areas. In wet years, sample at elevated or drier locations. In years following very cold and dry winters, look in areas with a history of damage.

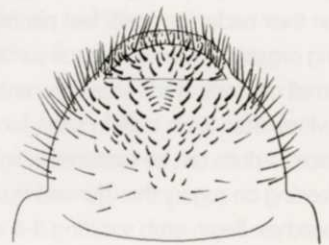
CONTROL STRATEGIES

Cultural: Where possible limit extra watering at vulnerable sites (to increase egg and first instar mortality) starting when adult flights peak. Increase drainage at wet sites and manage turf for maximum root production. Removal of trees or shrubs that exhibit adult feeding is unnecessary; adults can fly up to 5 miles per day.

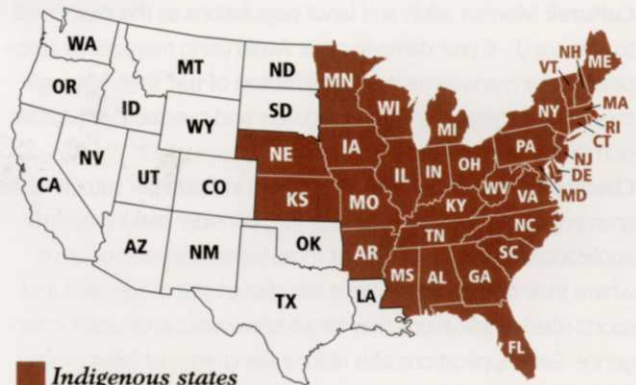
Chemical: Historically, infested areas can be treated preventively with MACH 2. Once regular sampling indicates that the per square foot grub population has reached 8 -10, consider making a curative control application to asymptomatic sites. At more vulnerable or low maintenance sites, applications may need to begin once grubs populations reach 3 - 5 per square foot.

RASTER PATTERN

In the field use a 10x magnification hand lens to view raster patterns.



DISTRIBUTION



■ Indigenous states

SOIL FEEDERS

MAY/JUNE BEETLES (M/JB)

aka: May Beetle, June Beetle, Junebug

scientific name: *Phyllophaga* spp.

FIELD KEYS

Hosts: Most grass species

Site symptoms: Turf wilting under heat stress despite adequate available moisture. Turf is unresponsive to fertilizer applications. Wilted turf turns off color and dies in irregular patches to large uniform areas. Removed dead or wilted turf reveals grubs feeding at soil - thatch interface down to 2-inch soil depth.

Plant symptoms: Above-ground plant structure shows no obvious damage or other symptoms. Root system shows much damage from the crown down to a 2-inch depth from grub feeding.

Site keys: Sunny locations with consistent soil moisture and moderate soil temperatures.

SPECIMEN ID

Immatures are typical six-legged white grubs with tan heads that range in size from ¼ inch for newly hatched first instars to 1½ inch fully-grown, third instars. Adults are ¾ to 1-inch light to dark brown beetles.

SCOUTING TIPS

Despite the large number of *Phyllophaga* spp. comprising M/JB, they all have a similar growth pattern - the majority of time is spent as 3rd instar grubs. Adult flights begin when evening temperatures are greater than 60°F. Adult numbers can be monitored with light traps and grub sampling should begin about four weeks after adult numbers peak. New adult emergence for different species may occur sequentially, so do a consistent job of classifying which species is seen when. Most M/JB species have multi-year life cycles. Vulnerable sites with infestation history should be sampled in May (second year grub) or August (first year grub) to avoid damage.

CONTROL STRATEGIES

Cultural: Where possible limit supplemental watering for about 4 weeks at vulnerable sites (to increase egg and first instar mortality) starting when adult flights peak. Increase drainage at wet sites and manage turf for maximum root production.

Chemical: Because of the number of different species and different life cycles involved in M/JB, it is important to correlate the data about grub populations with observed damage to develop a decision-making matrix. Or, consider making control applications to asymptomatic sites when grub sampling indicates that the per square foot grub population has reached 5-10. At more vulnerable or low maintenance sites, applications may need to begin once grubs populations reach 3-4 per square foot.

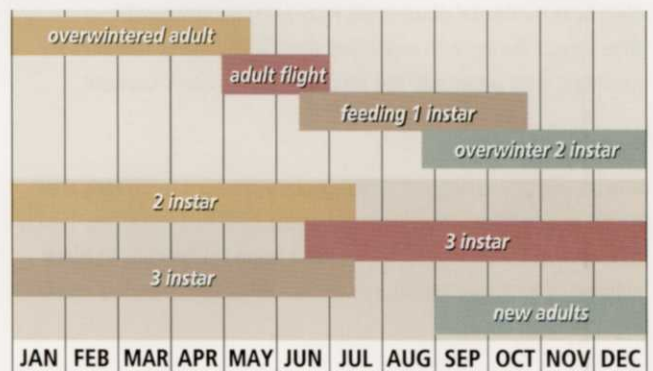


GRUB



ADULT

SPECIES ACTIVITY, BIOLOGY & LIFE CYCLE



Growth stages: egg - grub (three instars)* - pupa - adult

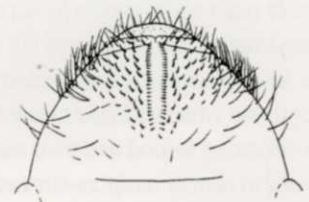
* - treatable stages

Life cycle: 1 to 4 year life cycle

Sequence: grub - pupa - adult - egg - grub

RASTER PATTERN

In the field use a 10x magnification hand lens to view raster patterns.



DISTRIBUTION



SOIL FEEDERS

ORIENTAL BEETLE (OB)

scientific name: *Anomala orientalis*

FIELD KEYS

Hosts: Most grass species

Site symptoms: Turf wilting under heat stress despite adequate available moisture. Wilted turf dies in irregular patches. Removed sod of dead or wilted turf reveals grubs feeding at 1-inch soil depth.

Plant symptoms: Above-ground structures show no obvious damage or other symptoms, however root system shows extensive damage at 1-inch depth from grub feeding. Nearby ornamental plant roots may also be damaged.

Site keys: Sunny well managed short and tall cut turf sites locations with adequate soil moisture and organic content.

SPECIMEN ID

Immatures are six-legged white grubs with light tan heads that range in size from 1/8 inch for newly hatched first instars to 1-inch fully grown third instars. Adults are a wide bodied tan to black colored, 1/2 inch beetles often with tan and black mottled markings on wing covers.

SCOUTING TIPS

OB over-winters at soil depths of 8 to 16 inches mostly as a third instar grub that begins to move up in soil to feed when soil temperatures reach 45°F. After pupation adults emerge in early to mid-summer. Adults are not strong fliers (usually less than 50 yards) and are usually seen during warm days with strong sunlight. At night adults can be found crawling on turf under lights. Grub sampling should begin at OB vulnerable sites 3 - 4 weeks after adult emergence. Late second instars may over-winter for a second year when soils cool below 50°F. Vulnerable sites with over-wintering second and third instars may show early feeding damage in heat or moisture-stressed springs.

CONTROL STRATEGIES

Cultural: If possible, limit supplemental watering at OB vulnerable sites (to increase egg and first instar mortality) starting 3 weeks after adult emergence. Increase drainage at wet sites and manage turf for maximum root production.

Chemical: Once regular grub sampling indicates that the per square foot grub population has reached 8 - 10, consider making control applications to asymptomatic sites. At more vulnerable sites applications may need to begin once grubs populations reach 3-5 per square foot.



SPECIES ACTIVITY, BIOLOGY & LIFE CYCLE



Growth stages: egg - grub (three instars)* - pupa - adult

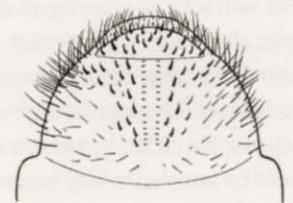
* - treatable stages

Life cycle: Mostly a 1 year life cycle (multiple generations)

Sequence: grub - pupa - adult - egg - grub

RASTER PATTERN

In the field, use a 10x magnification lens to view raster patterns.



DISTRIBUTION



Indigenous states

INSECT IDENTIFICATION GUIDE

A TURFGRASS ENTOMOLOGY RESEARCHER'S VIEW

Dr. David L. Shetlar, Ph.D.

MAACH 2 represents the first insect growth regulator-type insecticide to come to the turfgrass market. Insect growth regulators—or IGRs—have been known to entomologists for many years and several pesticides have been formulated and used successfully in other markets, especially in the greenhouse and forest arenas. The beauty of IGRs, in general, is that they have very low toxicity to non-insect groups. IGRs can take many forms, but most interfere with the hormonal systems that insects use to grow, especially the process of shedding their skin (molting). MACH 2 falls into a group of compounds that researchers have dubbed the “MACs” which stands for “molt accelerating compounds.” When ingested, these compounds “tell” an insect that it is time to molt, whether this would be the correct time or not. The insect undergoes the molt and often does not survive because it is too early for a normal molt. MACH 2 is one of the MACs that seems to remain stable in the turfgrass environment and has activity on white grubs and most of the turfgrass infesting caterpillars, cutworms and sod webworms.

Because of its unique mode of action, entomologists are excited about using MACH 2 in resistance management. Many insects have become resistant to traditional organophosphate or carbamate insecticides that adversely affect the nervous system. It is much more difficult for an insect to develop a new molting method that would counteract the action of MACH 2.

Another unique attribute of MACH 2 is its relatively long residual life in turf soil and thatch. Early tests have suggested that insect active residuals remain for 60 to 100 days, or more. This efficacy period opens up other opportunities for using MACH 2, that is, multiple targeting of pests. Our studies in Ohio have suggested that MACH 2 can be applied in late May or early June on golf courses to manage the first generation of black turfgrass atenienus grubs, keep down black cutworm damage for



about 60 days *and* knock down the normal annual grubs (Japanese beetles and masked chafers) that appear in late July and August. Lawn care companies could also take advantage of such multiple targeting. There is also good data to show that MACH 2 does very well at controlling sod webworm larvae.

For those serious about IPM principles, especially where sampling is a must before a control product is applied, MACH 2 appears to have considerable activity on second instar white grubs and early third instars. They are usually present in late August and early September. Therefore, MACH 2 can be used as an early curative control insecticide.

In summary, MACH 2 brings to the turf insect control arena a new chemistry, long residual activity, multiple targeting capability, as well as curative action.



Top: Dr. David Shetlar examines turf for grub counts.

Below: volunteers help with grub counts at Ohio State University research plots

INSECT IDENTIFICATION GUIDE

HOW TO USE MACH 2 -

MACH 2 is available in two convenient formulations - MACH 2 Granular and MACH 2 Liquid. MACH 2 Granular is approved for use on all turf sites including residential lawns, golf courses, athletic fields and sod farms.

MACH 2 Liquid is approved for use on commercial turf sites including golf courses, office buildings, sod farms and similar settings. The liquid formulation is not yet registered for use on residential lawns or athletic fields. Consult product label for additional information.

PESTS CONTROLLED AND USE RATES FOR MACH 2

PEST	Formulated Product Use Rate		Formulated Product Use Rate		REMARKS
	PER 1000 SQ FT	PER 1000 SQ FT	PER ACRE	PER ACRE	
	MACH 2 LIQUID	MACH 2 GRANULAR	MACH 2 LIQUID	MACH 2 GRANULAR	
Cutworms	↑	↑	↑	↑	Apply at first sign of pest damage. A single repeat application can be made if needed.
Sod Webworms	1.5 fl oz	1.55 lb	2 qt	67 lb	
Armyworms	↓	↓	↓	↓	
Fall Armyworms	↓	↓	↓	↓	
WHITE GRUB LARVAE SUCH AS:					
Japanese beetle	↑	↑	↑	↑	Make only one application per year
Northern masked chafer	↑	↑	↑	↑	
Southern masked chafer	↑	↑	↑	↑	
European chafer	↑	↑	↑	↑	
Oriental beetle	↑	↑	↑	↑	
Asiatic garden beetle	2.2 fl oz	2.3 lb	3 qt	100 lb	
May/June beetle	↓	↓	↓	↓	
Black turfgrass ataenius	↓	↓	↓	↓	
Green June beetle	↓	↓	↓	↓	
Annual bluegrass weevil	↓	↓	↓	↓	
Billbugs	↓	↓	↓	↓	

Note: A minimum of 1 gallon of finished spray per 1000 sq ft is required for adequate spray distribution.