FIGURE 4

Mean percentage spore viability in 2003 field study (Tri-State Sod Farm in Newton Grove, N.C.) 1, 3, 7, 14, 21 and 28 days after treatment.

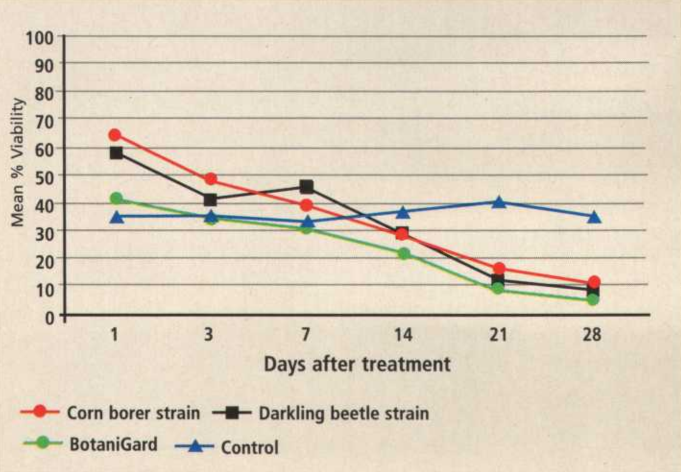
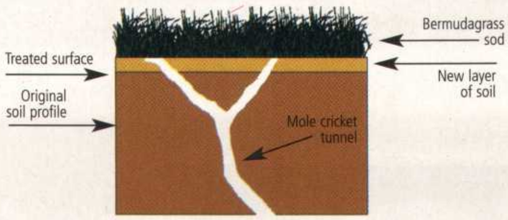


FIGURE 5



Design of mole cricket behavioral tests.

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tunnels), tunneling around the edges and the location of the cricket. Less vertical tunneling indicated that the crickets attempted to reduce exposure to the spores by minimizing the number of times that they passed through the spore layer. Little or no surface tunneling through the concentrated area of spores around the edges of the container also indicated an avoidance response. Additionally, finding the cricket in the top (read: new) layer of soil showed an attempt to reduce passages through the spore layer. The amount of new surface tunneling was also quantified.

Results from these studies suggest that mole crickets can detect the presence of *B. bassiana* and alter their behavior to minimize contact and infection. The changes in behavior were only significant with the darkling beetle strain and a conventional insecticide, bifenthrin. The corn borer strain invoked less-significant avoidance behaviors, while the grasshopper strain appeared to increase mole cricket activity.

Future research at North Carolina State includes an investigation of the influence of rates, formulation (baits), and time on mole cricket avoidance of biological control agents. Because the avoidance behaviors, like the spore viability and efficacy studies, appear to be strain-specific, we are optimistic that a strain, which is virulent, persists in the environment and remains undetected by the crickets will be isolated.

Conclusions

Studies like ours involving biological control agents for turfgrass insects are important to help tear down the barriers that exist with using these products in the field.

As societal concerns and environmental protection laws continue to increase, it's critical that we are prepared to offer alternatives for pest control in turfgrass that are reliable, practical, safe and cost-effective. Although many biological agents are not yet ready to put into use today, we are hopeful, based on our studies, that they may be a viable option in the near future.

Thompson is a graduate research assistant, and Brandenburg is a turfgrass entomologist at North Carolina State University in Raleigh.

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Sodium Plays Role in Certain Turfgrass Processes

By Richard J. Hull

Sodium (Na) constitutes about 2.8 percent of the earth's crust, in similar proportion to potassium (K) at 2.6 percent. Both elements are chemically similar and exist in soils as monovalent cations (they have a single positive charge). As such, they are bound to cation exchange sites on soil colloids.

However, positive sodium ions (Na^+) attract a larger shell of hydration water than does positive potassium ions (K^+). This thicker hydration shell partially insulates the positive charge of Na^+, making its electrostatic attraction to negative cation exchange sites slightly weaker than that of K^+. Thus, while both ions have a concentration of .1 millimoles (mM) to 1 mM in the soil solution of temperate region soils, Na^+ is more readily leached to the subsoil by percolating rain or irrigation water.

In arid and semi-arid regions where leaching occurs less frequently, irrigated soils often contain 50 mM to 100 mM Na^+ (often as salt, (NaCl). Such salt concentrations are toxic to many crop plants, including most turfgrasses.

Because high salt concentrations are common in soils of regions with limited rainfall or subject to tidal flooding, some plants have evolved mechanisms for tolerating excessive levels of Na^+. These plants are classified as natrophilic species or halophytes and are characterized by absorbing large amounts of Na^+ and negative chlorine ions (Cl^-), transporting them through the xylem to leaves. Then they are sequestered in the vacuoles of mesophyll and parenchyma cells. The high salt content of leaves lowers the cell's water potential and establishes a water-potential gradient through the xylem to the roots, where water has a higher potential. Thus, water can be absorbed from saline or drying soils and transported to the leaves following the water-potential gradient. Such plants tend to have the succulent leaves characteristic of many dry-land or coastal marsh plants.

Some halophytic plants can excrete excess salts to their leaf surfaces through salt glands. This feature is common to tidal marsh plants that grow in seawater and lose excreted salt to high tide floodwaters twice each day. Upland plants growing in saline soils can also have salt glands and discharge excess salts through them. Several warm-season turfgrasses possess salt glands, including bermudagrass, zoysiagrass and buffalograss.

In a recent study, K.B. Marcum et al. (2003) at Arizona State University in Phoenix reported that the density of salt glands on leaf surfaces of 15 zoysiagrass cultivars correlated positively with clipping production and turf quality when grown under high-salinity conditions. This confirms the long-held belief that salt-gland excretion contributes significantly to salinity tolerance in halophytic grasses. Since salt-gland density is a genetically controlled characteristic, these authors concluded that measuring salt-gland density should be a simple way of screening turfgrass genotypes for salt tolerance.

By comparison, most plants are intolerant of high Na^+ concentrations, and survive in the presence of elevated salt levels through root exclusion, efflux and sequestration of Na^+. These plants are known as natrophobic species or glycophytes. The K^+ transport channels in their root cells discriminate against Na^+ often by a ratio of 25 to 1 or more. Still, some Na^+ will enter the cells in amounts that are potentially toxic. To eliminate this problem, Na^+ efflux pumps in root cell plasma membranes excrete Na^+ out of the cells back into the cell walls in exchange for positive hydrogen ions (H^+) that enter the cell. Root cells normally transport H^+s across their plasma membrane into the cell wall (apoplasm), where the pH is lowered by two units below that of the cytoplasm. These H^+/Na^+ antiporters (H^+/Na^+ exchangers) can keep the cytoplasmic Na^+ levels to physiologically acceptable concentrations. If the H^+/Na^+ antiporters can't keep up with Na^+ influx, cortical and xylem parenchyma cells will accumulate the excess Na^+ in their vacuoles. The excess positive charges will be balanced by Cl- ions entering from the soil or by organic acid anions (usually malate or citrate) synthesized within the root cells. This process retains potentially toxic Na^+ within the roots, preventing it from entering the stems and leaves where it could be handled less easily. If all these defensive strategies are overpowered by excessive soil salinity, the plant will exhibit salt injury symptoms and probably be killed.

These various protective processes are not equally evolved in all salt-sensitive plants, so there is considerable variation in the degree of salt tolerance between true glycophytes and true halophytes. Most turfgrasses are glycophytes, although some can tolerate substantial salinity if the onset of elevated salt concentrations is not too rapid. They can invoke most of the Na^+ excluding and sequestering mechanisms. Only seashore paspalum (Paspalum vaginatum), weeping alkaligrass (Puccinellia distans) and perhaps the salt-gland equipped grasses mentioned above can be considered truly halophytic. Some cultivars of seashore paspalum are sufficiently salt-tolerant that they can be irrigated with seawater.

The relative salt tolerance of cool- and warm-season turfgrasses are presented in Table 2. It is evident that both grass types vary greatly in their tolerance to salinity, although warm-season grasses appear to be generally more tolerant. Among the most commonly used cool-season grasses, most have good tolerance except for Kentucky bluegrass, which rates poorly. The more commonly used warm-season turfgrasses exhibit excellent or good salt tolerance except for bahiagrass (which rates medium) and carpetgrass (which rates fair).

The adverse effects of Na^+ on turfgrass growth as a component of salinity were enumerated by Carrow et al. (2001) as follows:

- ion toxicity of high Na^+ levels in plant tissues;
- ion imbalance where Na^+ may inhibit K^+, calcium (Ca^{+2}), magnesium (Mg^{+2}) and manganese (Mn^{+2}) uptake;
- Na^+ influence on soil structural deterioration (deflocculation of clays); and
- Na^+ contributing to total salinity – osmotic stresses.

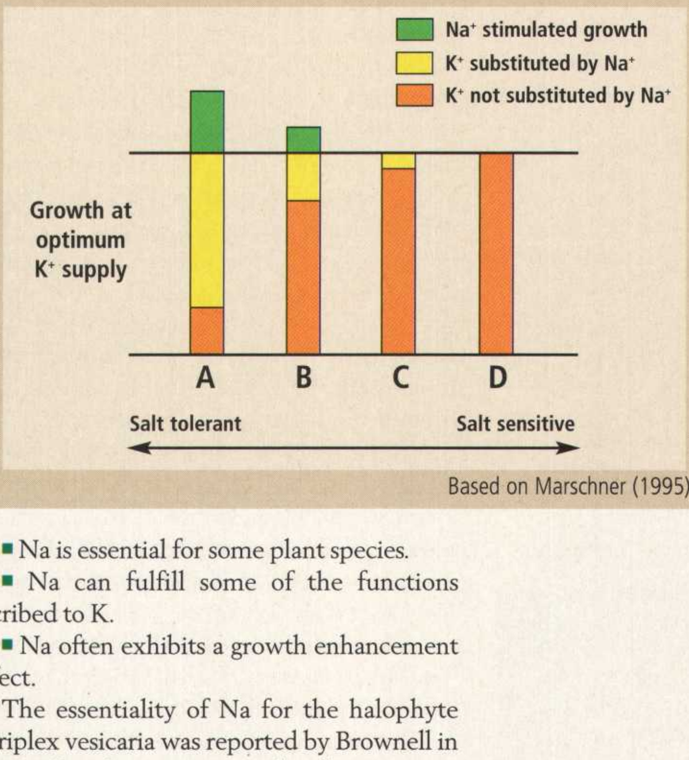
The principal problem of high Na^+ levels in the soil solution is its ability to displace Ca^{+2} from the outer surface of the plasma membranes of root cells. Calcium is essential for stabilizing the structure and association of integral proteins in the plasma membrane. Without Ca^{+2}, the proper structure of ion transporters can't be maintained, and cells become leaky and are unable to absorb nutrient ions properly or discriminate against toxic ions (such as Al^{+3}, Mn^{+2}, Se^{+2}).

Functions of Na^+

Even though salinity and Na in particular are considered abiotic stresses to most turfgrasses, small amounts of Na can be beneficial and even essential in some instances. Marschner cites three aspects of Na nutrition that should be considered:

FIGURE 2

Classes of plants based on Na^+ replacement of K^+ & Na stimulation of growth.



Based on Marschner (1995)

- Na is essential for some plant species.
- Na can fulfill some of the functions ascribed to K.
- Na often exhibits a growth enhancement effect.

The essentiality of Na for the halophyte Atriplex vesicaria was reported by Brownell in 1965. After eliminating virtually all Na contamination from nutrient solutions, plants became chlorotic and necrotic, followed by a cessation of growth. Supplying increased amounts of K failed to repair the injury caused by the lack of Na but providing micronutrient quantities of Na (20 micromoles (µM) to 100 µM) restored normal growth. In the early 1970s, the same authors (Brownell & Crossland, 1972) reported

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that a number of C^{-4} species (warm-season plants) showed deficiency symptoms when deprived of Na and failed to flower in some cases.

All C^{-3} (cool-season plants) that were studied grew well in the absence of Na. These findings prompted the conclusion that Na was indeed an essential nutrient to C^{-4} species but not C^{-3} plants. This interpretation of these data proved to be premature.

In these initial studies, glycophytic C^{-4} species (plants intolerant of high salt like corn and sugarcane) were not considered. When these plants were tested for their Na requirement, they were found to grow equally well with or without Na. It now appears that most salt-sensitive plants (C^{-3} and C^{-4}) have no requirement for Na, but those adapted to high salinity do require Na at low micronutrient concentrations.

In C^{-4} plants, carbon dioxide (CO2) is assimilated initially by bonding to a 3-carbon acid, phosphoenolpyruvate (PEP) in leaf mesophyll cells. PEP is reduced to the 4-carbon acid malate and transported to bundle sheath cells that surround the vascular bundles. There malate is decarboxylated releasing CO2 that accumulates to levels several times that of the atmosphere. Under this elevated concentration, CO2 is efficiently fixed to the 5-carbon sugar ribulosebisphosphate (RuBP) and the 6-carbon product spontaneously splits to form two molecules of the 3-carbon acid phosphoglyceric acid (PGA). The 3-carbon product remaining after decarboxylation pyruvate is returned to a mesophyll cell, where it enters a chloroplast and is phosphorylated to PEP and is ready to start the C^{-4} cycle all over again.

This ability to concentrate CO2 in bundle sheath cells, where photosynthesis really occurs, makes C^{-4} plants much more efficient than C^{-3} plants that must fix CO2 directly from the low atmospheric concentrations.

In glycophytic C^{-4} plants, pyruvate re-enters mesophyll chloroplasts through a cotransport process with a positive hydrogen ion (H^+). Apparently, in C^{-4} halophytic species, pyruvate enters chloroplasts through cotransport with a Na^+. This role for Na in some C^{-4} species was suggested when plants growing in a solution lacking Na were found to accumulate pyruvate in their leaves while PEP and malate declined to very low concentrations. The flow of pyruvate toward the regeneration of PEP was obviously disrupted, and pyruvate entry into mesophyll chloroplasts was a likely site for this disruption. Further studies by Ohnishi et al. (1990) involving mesophyll chloroplasts isolated from salt tolerant C^{-4} plants showed that pyruvate was absorbed readily, but only when Na^+ was present in 1 mM to 2 mM concentration. The Na^+ was also absorbed along with the pyruvate. When chloroplasts from salt-sensitive C^{-4} plants were studied, pyruvate absorption occurred in the total absence of Na^+. Thus, it appears that C^{-4} plants adapted to growth under saline conditions have evolved the use of Na^+ rather than H^+ to power the cotransport of pyruvate into mesophyll chloroplasts. This function is sufficiently limited that only micronutrient quantities of Na are required.

Without specifically determining their need for Na, one cannot predict with certainty which warm-season turfgrasses have essential Na requirements. Based on the above discussion, it appears that Na is essential only for warm-season grasses that have substantial tolerance to saline conditions. Thus, seashore paspalum, St. Augustinegrass, zoysiagrass and bermudagrass all likely require small amounts of Na for proper growth.

Substitution for K by Na

Because of their close chemical similarity, Na can substitute for several K functions in a number of plants. Marschner (1995) classified plants into four groups according to their growth response to Na:

- Group A — Na can substitute for a large proportion of the K needed by these plants, and the presence of Na stimulates additional growth that K cannot match (highly salt tolerant).
- Group B — A much smaller proportion of K can be replaced by Na, and growth responses to Na are less distinct.
- Group C — Na has no specific effect on plant growth, and it can substitute for only a small amount of K.
- Group D — Na does not substitute for K in any way and has no effect on plant growth (highly salt sensitive).

Those plants in groups A and B tend to be halophytic, while those in groups C and D are more glycophytic. In group A halophytes, Na not only can substitute for K in several functions but it can perform those functions better, resulting in greater growth than can be supported by K alone. This does not make Na essential for group A plants because such plants can grow well in the absence of Na in most cases. The capacity of Na to replace K should not imply that K is of minor importance in these plants, however. Group A and B plants permit the transport of Na^+ through the roots and into the xylem, where it's carried to the leaves with the transpiration stream.

There, most of it is loaded into vacuoles where it contributes in a major way to maintain proper osmotic relations within leaf tissues. In the cytoplasm and subcellular organelles, the Na^+ level is maintained well below that of K^+. Since the bulk of mature cell volume is vacuole, however, its high Na^+ content imparts a high Na concentration to leaf tissues. Young leaves of halophytic plants, having smaller, less vacuolated cells, invariably have a much lower Na content than older leaves.

Na stimulation of plant growth

It has been observed that the presence of Na^+ in the culture solution increases the growth of many natrophilic species (Marschner, 1995). Here, the major factor appears to be a stimulation of cell and therefore leaf expansion. This is attributed to Na^+ working more efficiently than K^+, as an osmoticum, thereby allowing greater turgor pressure to develop in cells causing enhanced expansion and growth.

Sodium ions enter vacuoles more readily than K^+ probably because of their slighter weaker positive charge. Sodium ions also have a depressing effect on starch synthesis but stimulate simple sugar (especially sucrose) accumulation. These small organic molecules lower water potential further, thereby promoting even more water influx and greater cell turgor.

When Na^+ contributes to the osmotic regulation of guard cells, stomates close more rapidly under drought stress and open more slowly when the stress is relieved. This maintains a more favorable leaf water status during periods of changing water availability and allows uninterrupted photosynthetic activity and greater growth. It should be remembered that these positive effects of Na^+ availability operate mostly in halophytic plants and have not been observed in glycophytes.

The beneficial aspects of Na^+ availability to plants have prompted the practice of applying Na salts as fertilizer to crop plants. This appears to have some benefit when:

- the crop is a natrophilic species;
- soil levels of K or Na are low; or
- when rainfall is irregular, causing transient drought during the growing season.

As a general rule, Na is not added as a fertilizer nutrient because natural sources are usually adequate to meet any beneficial effects on most turfgrasses. Various considerations in applying Na or irrigation water containing Na^+ and other salt ions are discussed in detail by Harivandi (1992). The total salt content as measured by electrical conductivity is generally more important than the amount of Na^+ present. Often, the potential injury caused by applying irrigation water containing salts can be partially reduced by including a calcium salt.

The $Ca2^+$ has a protective effect on root-cell membranes and helps them exhibit maximum selectivity in ion absorption. However, saline irrigation water must be managed carefully so as to avoid salt accumulation in the soil. This normally involves leaching salts from the soil with pure water once or twice each year. Rainfall can accomplish this, but another water source must be found if rain does not occur. Thus, a decision to use saline water for irrigation should be made carefully.

Since turfgrasses, especially warm-season grasses, differ dramatically in their tolerance to salt, planting resistant grasses is an excellent first step to avoiding salinity problems. Because salt tolerant warm-season grasses actually require small amounts of Na and often grow best when Na is present, including a Na-salt in the fertilizer mix is reasonable.

Also, irrigating such grasses with effluent water that contains low levels of Na^+ might be recommended. In many areas, effluent water from municipal or industrial sources is available when normal potable water is not, so there may be political or economic incentives for using it. If a turf is composed of salt-sensitive cool- or warm-grasses, Na^+ applications should be avoided especially if provided through irrigation water.

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As a general rule, Na is not added as a fertilizer nutrient because natural sources are usually adequate.

Expert Offers Six Keys for Successful Pest Control

By Rick Brandenburg

The effort to develop new pest control strategies for turfgrass never ends. The playing field is always changing as we see new regulations, new turf cultivars, new turf uses, higher expectations and demands, societal concerns over pesticide use and so on.

This ever-changing scene keeps researchers scrambling to develop pest control strategies that are effective, reasonable in cost, reliable, environmentally sound and easy to use.

That is a tall order to fill and requires input from university researchers, industry and turf managers. It also requires a significant level of funding to keep the whole research process rolling in a productive manner.

I believe that the future is good for the continued refinement and improvement of our pest control options so that the demands of turfgrass managers as well as society will be met. In this article, I'd like to discuss where I see the research leading us over the next 10 years and beyond in my particular area of expertise: turfgrass insect pests. I believe there are six areas that will become even more significant in the future and will provide improved approaches to managing these problems.

Forecasting: One of the major factors that render insects such a problem for turfgrass managers is their sporadic nature. Some pest problems, such as certain diseases or weeds, may occur almost every year in certain locations. Insects are often not the No. 1 problem for most turfgrass managers and may occur on a more sporadic basis. Their occurrence may also vary in timing by a few days or even months from one year to the next. Therefore, the main problem with insect control for many turfgrass managers isn't the actual control itself, but rather being able to detect and respond to the problem in a timely manner.

The abundance of environmental monitoring equipment makes keeping track of air and soil temperatures, rainfall, soil moisture, evapotranspiration (ET), and other environmental parameters quite simple, reliable and accurate. Since insects are cold-blooded and much of their development is regulated by temperature, forecasting is possible.

Forecast models have been and continue to be developed for a number of insects pests such as sod webworms, certain white grubs, mole crickets and cutworms. Some are actually in use on a limited basis, and others are still in need of local validation and refinement. Typically, however, factors other than temperature alone affect insect development. Certain aspects of insect biology such as egg-laying may be affected by rainfall, soil moisture and a possible interaction with temperature. This is true for mole crickets, for example, where spring egg-laying (and ultimately egg hatch) can vary by a couple of weeks depending on rainfall even if temperatures are the same.

FIGURE 1

Home page for the Turffiles Web site used for disseminating turfgrass information from the North Carolina State University program.

Our ability to stay on top of insect problems has become even more important since the dramatic changes in insecticide chemistries that have altered the pesticides that superintendents use today. More of our current products are focused on early interception of pest problems. A little later in this article I will discuss biological control. The need to be very timely with product applications is equally true for these control agents.

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PCNB- Questions and Answers

Following is a list of some of the most commonly asked questions and answers about PCNB turf products.

What are the effects on roots and soil mycorrhizae? (Mycorrhizae are fungi that are beneficial to root development)
PCNB will not affect mycorrhizae when applied at the highest labeled rates. Published studies have shown that PCNB will only impact root length and mycorrhizae when applied at rates much higher than the manufacturer's label allows. Research indicates that roots and mycorrhizae are negatively effected at rates greater than 20 parts per million.

▲ *Microdochium nivale* (pink) snow mold.

How safe is the material to the applicator and the environment?
This question can be answered in several ways:

EPA Signal Word: The EPA has designated PCNB as a category III material with a "CAUTION" signal word. The signal word is the degree of toxicity or hazard associated with a pesticide. The word "CAUTION" is required on the labels of all slightly toxic and relatively nontoxic compounds.

Improved Chemical Purity: Most of the historic "issues" with PCNB based products can be traced to the presence of impurities that were inadvertently produced during the early PCNB manufacturing process. Modern PCNB production has removed virtually all impurities to less than one tenth of one percent.

Leaching Potential: The water solubility of PCNB is one tenth of one part per million, and it is strongly adsorbed to organic matter. Therefore the material's capability to leach downward, or move offsite is extremely remote.

What is the potential of snow mold becoming resistant to PCNB?
PCNB is a broad spectrum, multi-site fungicide with several pathways that attack disease organisms. Therefore, unlike single site fungicides with only one pathway to attack disease organisms, resistance potential is low. There are no documented cases of snow mold becoming resistant to PCNB in over 50 years of use.

How do environmental conditions affect PCNB activity?
Temporary or transient increased disease pressure brought on by unusual climatic and/or management practices can sometimes result in unusually severe outbreaks of snow mold. For example, a long, snow free fall can adversely affect PCNB containing products because PCNB can be broken down by ultraviolet light found in sunlight. Additionally, excessive nitrogen plus warm fall temperatures result in succulent growth which is more susceptible to freeze damage and subsequent disease infestation prior to the arrival of snow cover. An over abundance of thatch can present problems in achieving effective snow mold control by preventing PCNB from contacting the soil and disease causing organisms.

All of these conditions combined (sunlight, warm temperatures and heavy thatch) can result in reduced availability of PCNB, which can adversely affect control. Fortunately this is a "Perfect Storm" scenario and rarely occurs. Successful snow mold control programs revolve around proper turf management and sufficient PCNB properly applied to contact the snow mold organism.

Does PCNB "build up" in the soil?
When used according to label directions, a build up of PCNB will not occur. There are no data available to indicate that persistence is an issue in turf.

Are any chemical companies supporting PCNB as a fungicide?
Several companies currently support PCNB in the turf market. PCNB activity on snow mold was first discovered 50 years ago. The Scotts Company and others further developed PCNB based turf products. The Andersons and AMVAC Chemical Corporation are committed to supporting PCNB by continuing to develop
and offer the most efficacious products to the turf industry and supporting PCNB throughout the Federal re-registration process. AMVAC introduced PCNB based products in 1991 and has a major investment in PCNB having constructed a multi-million dollar, state of the art technical manufacturing plant within their Los Angeles, CA facility. The ability of AMVAC to manufacture plant protection products such as PCNB in the environmentally sensitive Los Angeles area is a testament to its technical expertise and concern for the environment. In addition to turf use, PCNB is also used in ornamental applications, and on many agricultural crops, such as potatoes, cotton, beans, cauliflower and others.

PCNB has been on the market for many years. How effective is it today as a snow mold product?
Many university and private studies across the United States have been conducted over the years for snow mold control. PCNB has consistently ranked at or near the top in these studies. Combining PCNB with other active ingredients has been documented to provide enhanced gray snow mold protection. PCNB and PCNB combination products continue to provide outstanding snow mold control across the United States.

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Information delivery: The ability to forecast insect pests (this is also being done extensively for diseases) leads us naturally to a related area and that is transferring time valuable information to end-users when they really need it.

In today's world of e-mails and Web sites, that's so easy that it requires almost no effort. This technology is of great value to the turfgrass industry, and we probably have just scratched the surface on how to use it to its full effectiveness.

FIGURE 2

Effect of summer sulfur applications to turfgrass on green June beetle grub populations. Three-year average is the number of grubs per square meter.

Treatment	Rate (pounds/1,000 ft^2)	3-yr average
Sulfur	0.5	13.5
Sulfur	1.0	13.6
Untreated	-	24.6

We currently post frequent updates on the turf website at North Carolina State University (*http://www.turffles.ncsu.edu*)(Figure 1). Users can simply check the "Alerts" section each time they log on to determine if there are any warnings for potential or current pest outbreaks. These alerts may be based upon personal observations, reports sent in or weather conditions and forecast programs.

What makes the delivery of these warnings through the Web so valuable is that one can immediately access useful photos, techniques to detect and monitor the pest, as well as control recommendations.

Cultural practices: The use of cultural practices to manage insect pests has been an area that has never received a lot of attention, and perhaps it has been because we've been so focused on the cultural practices that enhance turf quality.

While there is much work to be done in this area, my experience has shown that applications of low rates of sulfur prior to and during the flights of the various white grub beetles dramatically reduce the subsequent level of grubs, for example (Figure 2).

Other studies have shown that properly timing the use of organic fertilizers and adjusting mowing heights can affect grub populations. Additional studies are investigating the role of endophyte-enhanced perennial ryegrass on insect populations. There are many exciting avenues of research under investigation that may allow us to reduce the likelihood of insect pest problems from even developing.

Wetting agents and adjuvants: This is an area that is receiving considerable attention these days for uses that almost exceed our imagination.

I don't know how much these products will influence the ability to use some current insecticides more effectively, but there is a lot of work just getting started to help us better understand how and when to use these products. I encourage you to pay attention to studies where these products are being used head-to-head in sound scientific studies to see if and how they can benefit you.

At this stage in my work with the products, I am noncommittal. I simply don't have enough data to make a strong case one way or the other, but there are a lot of testimonials that can be considered.

Biological control: This is an area that has always created a lot of excitement, but often seems to let many people down in its implementation. It seems that products and programs have come and gone through the years with little consistent progress. Many people look back on the old milky spore products for Japanese beetle grubs that have been around for decades as the one and only success story in biological control of insects in turfgrass.

There have been and continue to be different products on the market today that include entomogenous nematodes, fungi, bacteria and viruses.

There have been a number of products that have appeared on the market through the years that seem to simply disappear as quickly as they showed up. This may have been appropriate for some products.

One thing we know for sure is that many of the biological products cannot simply be sprayed and forgotten as we often do with conventional pesticides. In fact, it's perhaps unfair to even compare them side-by-side. They are two different beasts