Choosing an automatic controlled system should be like going to a good smorgasborg: the more you have to choose from, the greater your satisfaction will be.

That's why it's important to get together with Buckner during your initial planning stage. Because Buckner makes seven different types of controllers—more than anybody else.

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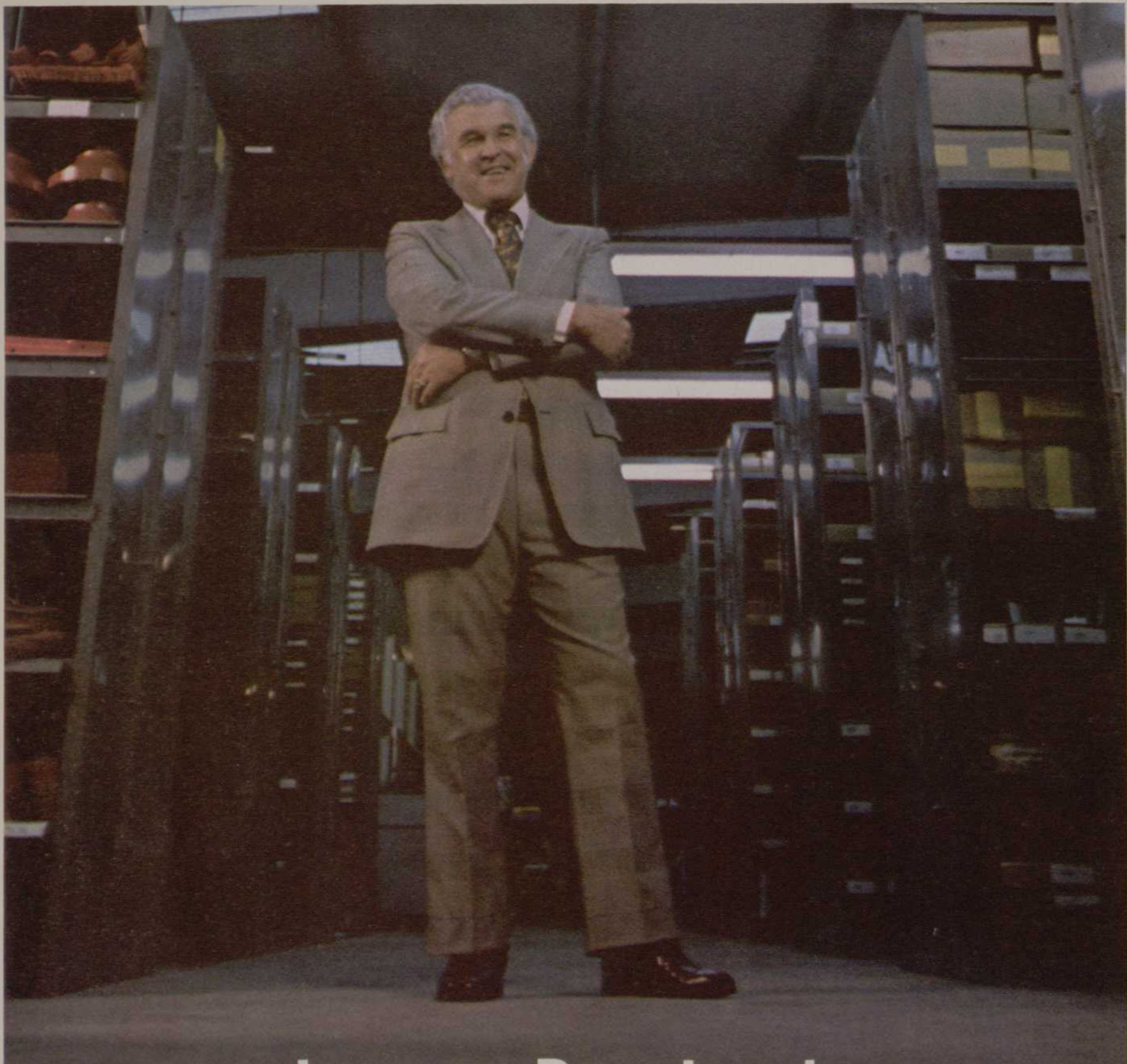

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## HOW MUCH ARSENIC FOR CONTROL?

***Soil factors influencing arsenic soil tests and growth of selected turfgrasses.** R.N. Carrow. 1972. Michigan State University Doctor of Philosophy Thesis. pp. 1-223 (from the Department of Crop and Soil Sciences, Michigan State University, East Lansing, Mich. 48823).*

The objective of this investigation was to study the influence of the soil's physical and chemical conditions on the arsenic toxicity of turfgrasses. Extensive laboratory studies showed the Bray $P_1$ arsenic extraction procedure to be the most reliable indicator of available arsenic levels in the soil. A number of golf courses in Michigan were then sampled and determinations of the arsenic levels made to assess the most appropriate levels to utilize in subsequent greenhouse and growth chamber studies.

The experimental procedure used included incorporating the arsenic throughout the soil mix prior to seeding. The soil mix containing arsenic was then placed into a replicated series of pots followed by seeding to either annual bluegrass (*Poa annua*), Penncross creeping bentgrass or Merion Kentucky bluegrass.

The results showed that the arsenic had no effect on seed germination of annual bluegrass, Penncross creeping bentgrass and Merion Kentucky bluegrass when the arsenic was mixed with the soil and incubated prior to establishment. The incubation involved placing the soil-arsenic mix in a polyethylene bag for a period of seven weeks with weekly wetting and drying cycles. However, some decrease in seed germination of Penncross creeping bentgrass occurred at medium high rates when the arsenic-soil mix was seeded immediately rather than incubating the mix for a seven week period. The Bray $P_1$ arsenic extraction procedure revealed that the available arsenic levels were reduced during incubation.

Experiments concerning arsenic effects on shoot growth revealed that arsenic inhibited the growth of all grasses. The degree of reduction, from highest to lowest, ranked in this order: annual bluegrass, creeping bentgrass and Merion Kentucky bluegrass. Merion Kentucky bluegrass was consistently more tolerant of soil arsenic levels than was the Penncross.

Investigations of the phosphorous-arsenic interrelationships showed that high phosphorous levels tended to reduce the arsenic toxicity. However, the magnitude of influence was not great. Also, the arsenic toxicity to annual bluegrass was less effected by increasing phosphorous levels than for such species as Penncross creeping bentgrass and Merion Kentucky bluegrass.

Investigations of the soil reaction-arsenic toxicity interrelationships indicated a marked influence on turfgrass growth and arsenic toxicity achieved on annual bluegrass increased as the soil pH was decreased from 7.8 to 4.3. The amount of Bray $P_1$ extractable arsenic also increased as the soil pH was lowered. The greatest increase in arsenic toxicity occurred between the pH's of 6.0 and 4.5. The magnitude of the soil pH influence on arsenic toxicity was much greater than the phosphorous-arsenic interaction.

*continued on page 14*

**BEARD** *from page 13*

Evaluation of arsenic toxicity over a range of soil textures revealed that arsenic activity decreased as the clay content increased. This response was also correlated with higher levels of extractable aluminum which may also have an effect. Finally, the extractable arsenic levels were generally highest in soils maintained at field capacity compared to the same soils maintained at levels of 70 to 85 per cent of capacity.

*Comments*: The first decision on golf courses where annual bluegrass is or has a potential for becoming a significant component of the golf course fairways is (a) whether cultural practices should be adjusted to maintain it or (b) to control it through adjustments in cultural practices and/or the use of chemical control procedures. The procedure to follow depends on the environmental and soil conditions in a given locality. There are a number of locations throughout North America where the best approach is to manipulate the annual bluegrass population in turfgrass communities strictly by cultural practices. There are other situations where chemical control procedures should be seriously considered. The above paper addresses itself to the latter situation and even more specifically to the considerations involved in the use of calcium arsenate $(Ca_3)$ $As04)_2)$.

A review of the history of calcium arsenate use reveals specific situations where excellent control of annual bluegrass has been achieved with no visual effects to the desirable species, particularly Kentucky bluegrasses. In contrast, there are also locations where serious problems have occurred in terms of phytotoxicity to the desirable species. The work reported in this paper assists in explaining some of the variability.

Calcium arsenate can be used very effectively in the control of annual bluegrass as indicated in the above paper. Annual bluegrass is much more sensitive to phytotoxic arsenic levels than are either the bentgrasses or Kentucky bluegrasses. The investigation also shows that arsenic has a

*continued on page 18*

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**BEARD** *from page 14*

minimal effect on the seed. Phytotoxicity develops after the seed has germinated and a sufficient quantity of roots is produced so that the arsenic is absorbed and translocated to the sites of phytotoxic action causing a relatively slow physiological death.

The basic problem with this herbicide and most others that are being considered for use in the control of annual bluegrass in fairways is avoiding phytotoxicity to the desirable species, such as Kentucky bluegrass and creeping bentgrass. The following considerations can be emphasized based on Carrow's word and supported by numerous field observations.

First, the Kentucky bluegrasses are much less sensitive to arsenic toxicity than the creeping bentgrasses. Field observations indicate that a majority of the successful fairway conversions from annual bluegrass to desirable species has involved Kentucky bluegrass. Unfortunately the margin of safety between the level of arsenic required for the control of annual bluegrass and the level of arsenic that results in phytotoxicity to creeping bentgrass is much less than for Kentucky bluegrass. As a result, greater difficulty may be faced in terms of potential arsenic phytotoxicity where the fairway conversion involves creeping bentgrass.

From the standpoint of soil chemistry, Carrow's work stresses that the soil reaction is far more important in influencing arsenic toxicity than the soil phosphorous level. Increased phosphorous levels, particularly in the higher range, will result in a higher level of arsenic required to achieve annual bluegrass control. However, the effect of soil pH, particularly as it is decreased from 6.5 to 4.5, greatly increases the arsenic availability and thus results in a substantially reduced rate of arsenic required to achieve annual bluegrass control. This explains why the rate of arsenic that has been used safely in the Midwest on less acidic soils is more toxic to the desirable species if it is used on the East Coast where the soils are more acidic in reaction.

From a soil physical standpoint, clay soils tend to reduce arsenic toxicity. Thus, higher levels of arsenic will be required to achieve control on soils having a high clay content. However, soils high in clay frequently have a soil drainage problem. The work of Carrow indicates that soils near field capacity will have an increased level of arsenic available for absorption by the plant. Here again this confirms field observations. Poorly drained depressional areas and wet soil conditions have resulted in serious arsenic toxicity to both the Kentucky bluegrass and creeping bentgrass species. It has been suggested, but not well documented, that surface water movement may carry arsenic particles into the lower areas resulting in increased arsenic levels in those sites and an inability to establish Kentucky bluegrass species. Carrow's work also suggests that the actual water level may affect the quantity of available arsenic.

It is obvious from this discussion that there are a number of soil

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# PROFESSIONALS...

## gained substantially in sales of major equipment; soft goods sales reached a five-year high

Pro shop sales in 1972 broke out of a two-year slump with almost a 25 per cent increase to $272.8 million worth of merchandise. Every major category of hard and soft goods realized a healthy gain.

Golf ball sales, the traditional leader, received an extra boost from the introduction of some innovative golf ball designs in 1972. Nationally, golf ball sales in pro shops leaped 28.3 per cent to $55.7 million.

In other hard goods categories, irons and woods made significant gains, and sales of putters and utility clubs declined only slightly. However, sales of all four combined jumped more than $10 million dollars from $62.5 million in 1971 to $72.8 million in 1972. Again, new designs and materials stimulated customer interest in clubs last year.

Soft goods again proved to be a leading pro shop money maker. Combined men's and women's apparel sales totaled almost $59 million —the best figure reported in five annual studies. For the third consecutive year, sales of men's and women's apparel ran about even.

In 1971, soft goods saved the day for many pro shops that were having trouble moving major equipment. The economic climate that year discouraged large purchases. However, 1972 reflected renewed interest in clubs, and 1973 promises to be a banner year for golf club sales, with almost every manufacturer introducing design changes and investment cast stainless steel clubheads. With relatively few on the market in 1972, clubs with investment cast heads already accounted for 26.5 per cent of club sales.

Professionals were not as successful with the teaching side of their businesses. Income from golf lessons dropped off almost 12 per cent in 1972 to $11.9 million. Uncooperative weather in many areas of the country accounted in part for this decline.

Figures on pro net income indicate that whatever gains professionals made in shop sales were, in great part, absorbed by rising business costs. There was little upward mobility noted. Some 8.9 per cent of the pro respondents reported net incomes of more than $25,000, versus 3.8 per cent in 1971. However, this still is a small percentage by comparison with the number of professionals at the lower end of the scale.

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(See page 45 for statistics on pro income from tennis merchandise and page 48 for information on pro income from golf car rentals.)

### PROFESSIONALS' TABLES AND GRAPHS