

involves the import and storage of Cl⁻ within vacuoles.

The extension of stigmas during anthesis of grass flowers requires a rapid influx of solutes and Cl⁻ along with K⁺ serves this function. Many specialized rapid osmotic changes such as the movement of *Mimosa* leaves when touched, require the transport of Cl⁻ ions. Xylem and phloem transport also depends on the influx of Cl⁻ from surrounding cells in many plants. Although other ions can often substitute for Cl⁻, osmotic adjustment is probably the plant function most sensitive to a Cl deficiency.

Cell division and expansion: The most common Cl deficiency symptom is a slowing of growth and a reduced leaf size (Marschner, 1995). Smaller leaves result from a reduction in cell divisions and the failure of cells to expand fully. This is more than an inadequate osmotic adjustment providing insufficient cell turgor to drive cell enlargement.

At this time, there is no clear explanation for the role of Cl in cell division and expansion. However, 4-Cl-Indoleacetic acid (4-Cl-IAA) has been isolated from several legumes during seed development (Pless et al., 1984), and the highest concentrations corresponded with the time of maximum water accumulation and cell enlargement. This chlorinated auxin is about 10 times more active than IAA. While its presence has not been confirmed as a general occurrence during cell enlargement, it might indicate that chlorinated growth regulators are essential for full auxin function.

More than 130 chlorinated organic compounds have been detected in plants (Engvild 1986), but their functions remain largely unknown.

Chlorine in turfgrass management

As indicated at the outset of this discussion, a Cl deficiency has yet to be reported for turfgrasses. That is not to say that turf never experiences insufficient Cl for optimum growth.

Deficiency in grasses normally involves wilting along the margins of leaves followed by necrosis. Reduced leaf growth is also evident, but these deficiency symptoms have been observed on grain crops under laboratory conditions. They would be much less easily detected on fine-leaved turfgrasses.

Chlorine is highly mobile in both xylem

TABLE 2

Causes of high Cl levels in turfgrass management

- Using irrigation water high in Cl⁻ salts.
- Seawater flooding or spray and salt water intrusion in ground water.
- Capillary movement upward from saline water table or subsoil.
- Insufficient leaching of Cl⁻ due to low rainfall and irrigation or poor soil drainage properties.

SOURCE: BASED IN CARROW ET AL. 2001

and phloem of plants so it is readily distributed to sites where its need is greatest. This further reduces the likelihood of Cl ever being truly deficient.

Nevertheless, the turf manager should be mindful that Cl is essential and optimum turf performance depends upon adequate Cl being present and in proper proportion with other elements. While Cl will normally be sufficient, it is still useful to include it in fertilizers. This is not a problem because the most common source of K is KCl, and that alone will more than meet the Cl needs of plants.

On sand-based putting greens, where leaching of anions is likely and turf clippings are removed, an incipient Cl deficiency may occur

On sand-based putting greens, where leaching of anions is likely and turf clippings are removed, an incipient Cl deficiency may occur. In other less well-drained sites, there is the potential of excess Cl⁻ reducing the uptake of nitrate and even phosphate or promoting excess nitrate immobilization in the vacuoles of root and leaf cells.

Thus, applying half of the K as K₂SO₄ may insure an appropriate balance between Cl⁻ and other nutrient anions.

In turf management, excess Cl is more like-
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ly to be a problem especially where salinity levels are high (Carrow et al., 2001). Turfgrasses vary in their sensitivity to salinity with the most sensitive exhibiting toxicity symptoms when Cl concentrations become .3 to .5 percent of leaf dry weight. Tall fescue and perennial ryegrass can tolerate Cl⁻ levels in the soil solution of 40 mM while bermudagrass and paspalum can grow without injury in 100 mM Cl⁻.

Excess Cl⁻ levels are likely to result from both environmental and management factors (Table 2).

Chlorine toxicity can cause leaf chlorosis and markedly reduce growth rates. It can be mitigated by using sulfate salts as fertilizer materials and by increasing the calcium levels of the soil. Clipping removal may also reduce Cl toxicity over time, especially if other corrective measures are taken. While Cl is the micronutrient required in the greatest amount, it's among the least likely to be deficient.

Fertility management should consider Cl

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requirements especially on light readily drained soils or sands where clipping removal is standard. However, the potential for Cl toxicity must also be considered on poorly drained soils where poor quality water is being applied. Balancing the Cl supply to turf is a reasonably challenging aspect of turfgrass management.

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TURFGRASS TRENDS

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Extra-Value Meals

Combination fertilizer products provide superintendents the opportunity to do two jobs for the price of one.

But companies aren't marketing them aggressively.

What gives?

By Frank H. Andorka Jr.
Managing Editor

Don Johnson loves combination fertilizer products. The vice president and general manager of professional products for J.R. Simplot says they're a great bargain for superintendents because using a granular fertilizer that also includes a pesticide saves superintendents time and money.

"The labor savings on these products is enormous," Johnson says. "Some of the new control chemicals work even more efficiently in granular than in spray form. They give superintendents more bang for their bucks."

Yet manufacturers report that sales of combination products have remained flat after growing significantly shortly after they were introduced more than 25 years ago. They point to a variety of factors, including the natural cautiousness of superintendents about trying new products, the limited number of control products currently offered as part of a fertilizer package and cost.

But one manufacturer says the profit margins on combination products aren't high enough for some companies, so they're not promoting them as alternatives to a traditional two-step chem-



ical application program. So though these products have emerged as a solid segment of the chemical market, manufacturers expect sales to remain stable instead of continuing to grow at a fast pace — unless companies can find ways to make combination products more profitable.

Saving time and money

Two issues typically spur superintendents to use combination products, according to Steve Jedrzejek, senior product manager for combination and control products for LESCO. One is the convenience of putting down two applications at the same time, which saves time and money in times of tight budgets.

The other is the concern some superintendents have about potential pesticide drift for spray applications. Some superintendents are concerned about public perception when it comes to spraying. As Johnson says, "When people see a spreader, they don't panic because they've spread fertilizer on their own lawns. When they see a sprayer, sometimes they do panic, even when what's being sprayed is perfectly safe."

Jedrzejek says granular combination products help alleviate some of those concerns. In addition, it's easier for superintendents to use granular control products instead of sprays in some states because there are fewer product-use restrictions.

Combination products also offer superintendents a significant cost savings in some cases, depending on the quality of fertilizer and control products, says Mike Bandy, marketing manager of turf products for The Andersons. Quantitatively, the savings would be at least \$5 per 50-pound bag for a fairway/rough product, but it could easily be \$15 per bag or more for a greens/tees product, he says.

"You also can't forget the savings in labor," Bandy says. "By making one application instead of two, you're allowing the crew members to do other equally important jobs. Combination products allow superintendents to use their labor more efficiently."

It's also easier to apply a pesticide in

granular form when it's been added to a fertilizer than a spray, Bandy says. "It's less complicated, and with more superintendents using less-experienced employees, that's an advantage as well," Bandy says.

Finally, Johnson says the cost of combination products, though sometimes more expensive than either fertilizers or

pesticides alone, are usually cheaper than purchasing the two products separately.

Not for everyone

Jedrzejek says combination products aren't for everyone, however. He says they are only workable if the schedules for fertilizers and control products are in sync.

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Extra-Value Meals

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"There's more flexibility with a spray," Jedrzejek says. "When you use combination products, you must apply both products at the same time."

Gary Neyman, sports turf manager for Lebanon Turf Products, says another potential drawback for combination products is that not all control products are suitable for combined use.

"Some materials don't lend themselves easily to combination formulations because the fertility requirements and tim-

ing might not mesh with the need to control a particular pest or problem," Neyman says. "In some ways, that limits the pests superintendents can control with these products."

Traditionally, the control products most often combined with fertilizers are pre-emergent herbicides because the application schedules often coincide, Neyman says. Jedrzejek says

about 70 percent of the combination products sold by LESCO are fertilizers with pre-emergent herbicides. There are also combination products with fungicides and insecticides, but those are less common. Jedrzejek says 25 percent of the LESCO combination product sales are insecticides, and the final 5 percent of the market is made up of fungicides, wetting agents,

Measure Twice for Best Performance

According to Mike Bandy, marketing manager of turf products for The Andersons, there are two key components in making sure the combination product you buy will perform as expected.

One standard measurement to understand is the size guide number or SGN. It is defined as the average particle size of a granular product, expressed in millimeters, multiplied by 100. A product with an SGN of 240 has an "average" particle size of 240 millimeters. Bandy suggests superintendents use products with an SGN of 100 on greens, 125 on tees and surrounds, 150 on fairways and 215 on roughs.

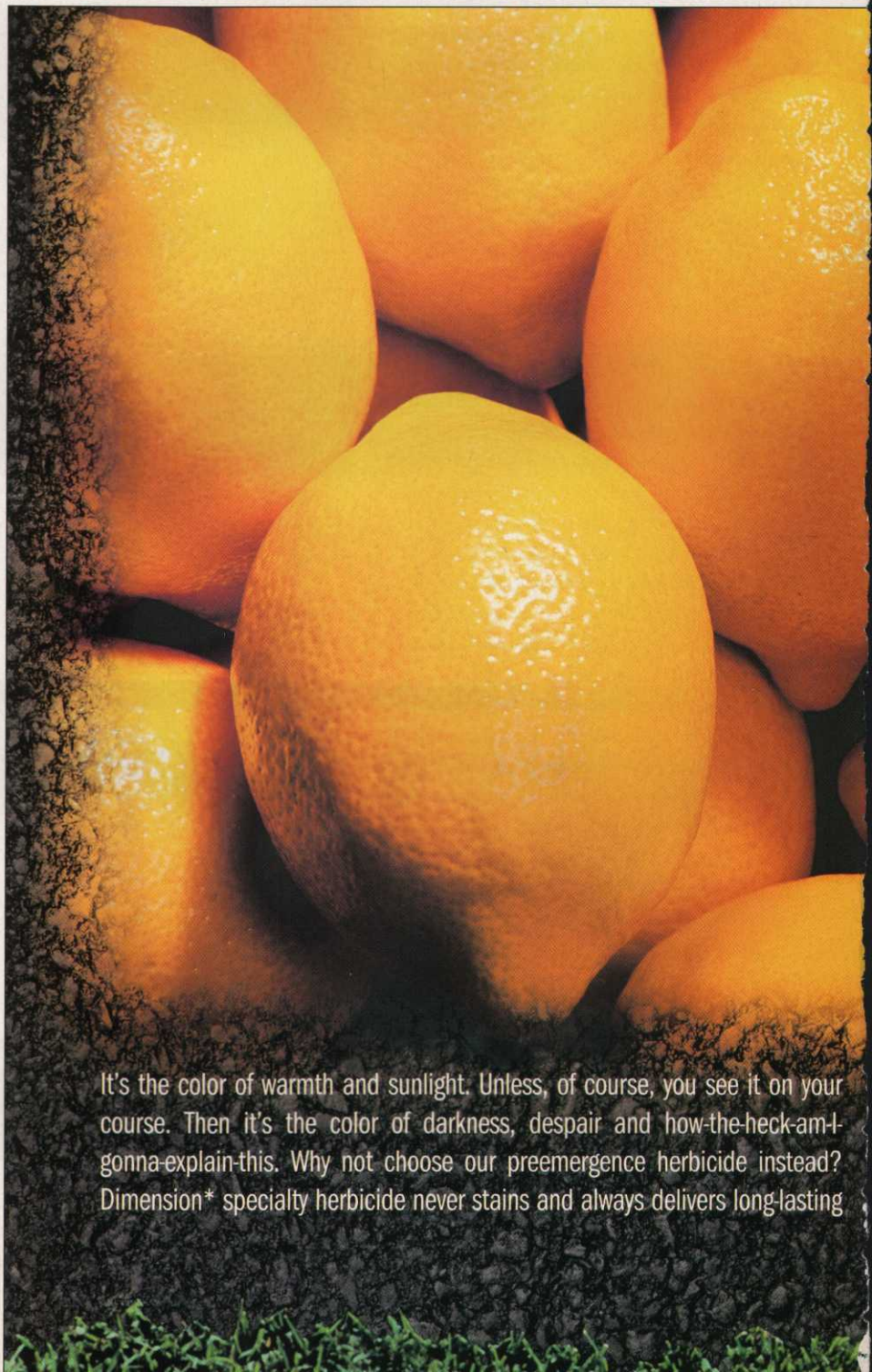
But Bandy says that average size is only half the story.

"A product that has every particle sized at SGN 240 is better than a product that has half the particles sized at SGN 120 and half at SGN 360, even though both products have an average SGN of 240," he adds.

Quantitatively, the second measure is referred to as Uniformity Index (UI). This calculation is more complicated than SGN because it uses statistics. Typically, the industry will refer to a product as being "good" or "not good" when referring to consistent sizing, Bandy says. "There are UI measurements that coincide with this, but they are not commonly used," he says.

Bandy recommends superintendents find out the UI of the product to ensure even coverage.

— Frank H. Andorka Jr.,
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