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throughout the season in a number of states.)

In certain parts of the country, pre-emergence applications can begin six to eight weeks before expected crabgrass germination; under cool soil temperatures little, if any, degradation occurs during this period.

Reseeding interval—The time between application and reseeding may affect herbicide choice. Herbicides that control annual weeds may also affect new seedlings of desirable turfgrasses.

The overseeding or reseeding interval depends on herbicide characteristics and the rate applied (Table 6). When reseeding, proper management practices such as soil cultivation, irrigation and fertilization must be followed. Also, turfgrass seeds should be placed in contact with the soil.

TABLE 4

ANNUAL GRASSY WEED CONTROL RATINGS FOR PRE-EMERGENCE HERBICIDES

Herbicide	Crabgrass	Goosegrass	Annual Bluegrass
Atrazine	P	P	E
Benefin	G	F	G
Benefin + oryzalin	G	F-G	G
Benefin + trifluralin	G	P-F	G
Bensulide	G	P	G
Bensulide + oxadiazon	G	G	G
DCPA	G	P	G
Dithiopyr	G	G	G
Metolachlor	F-G	F	F-G
Napropamide	G	G	G
Oryzalin	G-E	G	G
Oxadiazon	G	G	G
Pendimethalin	G-E	G	G
Siduron	G	F	NR
Simazine	P	P	E

Weed control effectiveness: E = excellent (90-100%), G = good (80-90%) F = fair (70-80%), P = poor (<70%), NR = not registered

TABLE 5

PRE-EMERGENCE HERBICIDES FOR USE WHEN ESTABLISHING TURFGRASSES

Situation	Herbicide
Cool-season turfgrasses seeded the previous fall	Balan 60 DF, Betasan, Bensumec, Lescosan, Dacthal, Ronstar, Tupersan
New turfgrass seedlings when 1 to 2 inches in height	Dacthal
New seedlings of cool-season grasses	Tupersan
Sprigging bermudagrass	Chipco Ronstar 2G, 50WP*, Atrazine, Princep
Sprigging zoysia	Tupersan

** Ronstar 50WP has a 2(ee) recommendation in the following states: AL, AZ AR, CO, FL, GA, HI, LA, MD, MS, NC, NM, SC, TN, TX AND VA*

TABLE 6

OVERSEEDING OR RESEEDING INTERVALS

Weeks after application	Pre-emergence herbicide	Rate: Pounds active per acre
6	Balan, 2.5G, 60DF, XL 2G	2
8	Dacthal 75W, 6F Team 2G	10.5 2
12	Dimension 1EC	0.5
12 to16	Balan 2.5G, 60DF Team 2G XL 2G	3 3 3
16	Betasan 4E, etc. Pre-M 60DG Ronstar 2G, 50W Surflan 4AS Weedgrass Control	10 3 4 3 4 to 6
24	Devrinol 50WP, 2G, 5G Pennant 7.8E	3 4

Herbicide carriers—Herbicides may be formulated as dry granules including fertilizer carriers or sprayable products. Sprayable herbicides are primarily applied in a water solution; certain ones may also be applied in liquid fertilizer (Table 7). Adequate mixing in the spray tank and agitation during application is absolutely essential, as is uniform spray distribution.

Pre-emergence herbicides need rainfall or irrigation to move them off the sprayed turf foliage into the upper soil levels where weed seeds germinate. If at least one-half inch of rain doesn't fall within a week after application, irrigation is advisable.

Pre-emergence broadleaf control—Herbicides principally applied for annual grassy weeds will provide pre-emergence control of certain winter annual and summer annual broadleaf weeds.

Isoxaben (Gallery 75 DF) is a pre-emergence herbicide for control of certain broadleaf weeds in established turfgrasses. Gallery is applied in the late summer or early fall for winter annual broadleaf weeds, and in early spring for summer annual broadleaf weeds. Because Gallery is a pre-emergence herbicide, it does not control established weeds. These should be controlled with post-emergence herbicides. Certain perennials—for example, dandelions and plantains—are controlled from seed. Gallery will fit into a weed management program to supplement the pre-emergence herbicides which are primarily used for the control of annual grassy weeds.

—Dr. Bill Lewis is in the Crop Science Department at North Carolina State University, Raleigh, N.C. All tables used supplied courtesy of the author.

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TABLE 7

EXAMPLES OF BROADLEAF WEEDS CONTROLLED BY GRASS PRE-EMERGENCE HERBICIDES

Herbicide	Common chickweed	Mouseear chickweed	Henbit	Hop clover	Y. wood sorrel	Carpet-weed	Prostrate knotweed	Prostrate spurge	Common purslane
Betasan, etc.			●						
Dacthal	●					●		●	●
Devrinol	●					●	●		●
Dimension					●				●
Pre-M	●	●	●	●	●			●	
Ronstar					●	●		●	●
Surflan	●		●			●	●	●	
Team					●			●	
Weedgrass Control	●	●	●	●			●	●	●
XL	●		●			●	●		●

Potassium and grass production

Most U.S. soils are low to marginal in soil potassium reserves and require potassium fertilization for healthy turfgrass growth.

by Jerry B. Sartain

■ The element potassium aids winter survival, disease resistance, promotes root growth, and increases the hardiness of grasses. It's second only to nitrogen in turfgrass tissue. So, in most instances, the addition of potassium fertilizer is needed to avoid a deficiency.

In some respects, potassium is a mystery. Its specific roles in plant growth aren't completely known although it's believed to act as a catalyst.

It seems to be involved in the formation of proteins and carbohydrates, and translocation of assimilates.

Influence of potassium—In long-term studies on a sandy soil, the growth rate of Tifway bermudagrass was positively influenced by potassium; but thatch accumulation was not enhanced (Fig. 1). Potassium significantly increased the total dry mass of roots (Fig. 2). Belesky and Wilkinson reported in 1983 that Coastal bermudagrass yield was improved by increasing potassium rate, regardless of N source, while Tifton 44 yield was not improved by increasing potassium when $NaNO_3$ was applied.

Other researchers have reported no growth response to the application of potassium.

Differences in response to potassium fertilization relate to the soil type and the status of soil potassium at fertilization.

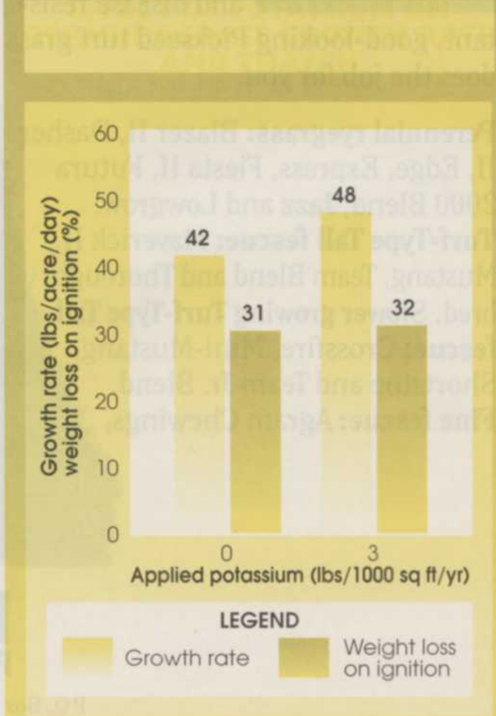
If the soil contains large reserves of exchangeable potassium or primary potassium minerals, such as mica and feldspars, growth response to potassium fertilization is not probable. On the other hand, turfgrasses growing in sandy or clayey soils of low potassium reserves need potassium fertilization for optimum growth.

In areas of high rainfall and mean daily temperature, potassium fertilization is necessary. As a general rule, most U.S. soils are low to marginal in soil potassium reserves and require potassium fertilization to optimize growth.

Increasing rates of potassium increase rhizome production, root mass and stand quality of bermudagrass. Spring stand quality is directly related to rhizome production the previous fall.

By applying more potassium, winter survival of turfgrass is enhanced. In many studies, a balanced fall fertilization program involving nitrogen and potassium has enhanced cold hardiness and winter survival of warm-season turfgrasses. Reducing potassium fertilization rate has also resulted in an observable loss of root system vigor.

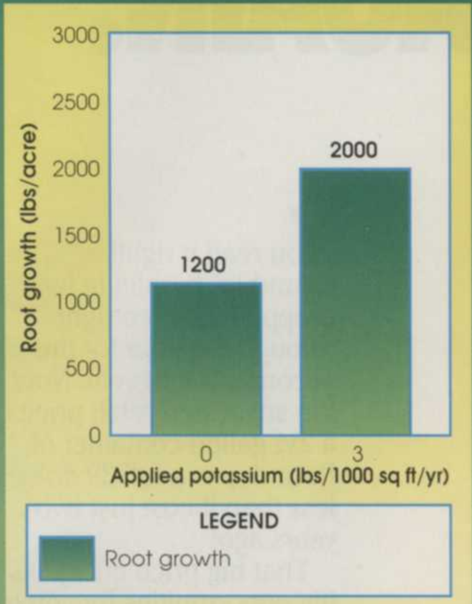
FIGURE 1



Source: The author

FIGURE 2

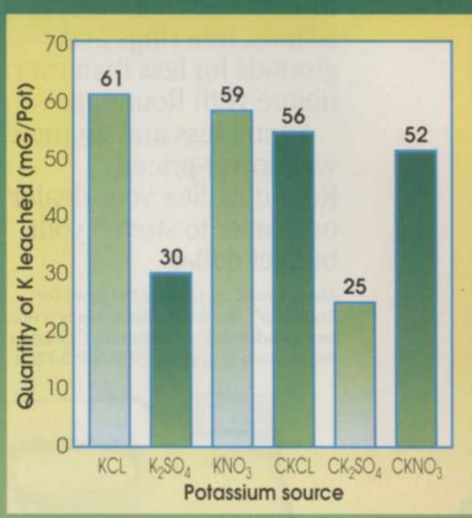
EFFECT OF POTASSIUM ON BERMUDAGRASS ROOT GROWTH



Source: The author

FIGURE 3

EFFECT OF POTASSIUM SOURCE ON QUANTITY OF POTASSIUM LEACHED



Source: The author

FIGURE 4

MAJOR POTASSIUM SOURCES

Source	% Potassium	% K_2O	Salt index
Potassium chloride (muriate of potash)	50-52	60-63	1.94
Potassium sulfate (sulfate of potash)	42-44	50-53	0.85
Potassium magnesium sulfate	18	22	1.97
Potassium nitrate	37	44	1.58

Source: The author

In Texas, the incidence of leaf spot (*Helminthosporium cynodontis* Marig.) was increased in bermudagrass test plots when phosphorus was supplied without potassium, demonstrating the need for a balanced fertilization program.

Potassium sources—Potassium is taken up by the plant roots in the K+ form. This can be supplied by either soil reserves or fertilizer salts. Soil reserves are generally low in sandy, highly leached soils. Therefore, potassium for turfgrass production is generally supplied by application of potassium fertilizer salts.

Potassium chloride is the most commonly-used commercially-available potassium fertilizer. Because of this material's high analysis and low production cost, it is very popular.

Potassium sulfate is used on crops and soils on which a fertilizer with a lower salt index is needed. One of the perks of applying potassium sulfate is the addition of sulfate sulfur, which many of our soils now require.

Potassium magnesium sulfate, because of its advantage of supplying both magnesium and sulfur, is frequently used in soils that are deficient in these two elements. The relatively low potassium content of this product limits its inclusion in high-analysis fertilizers.

Potassium nitrate is an excellent source of both nitrogen and potassium but, due to cost, is used mostly on crops of high acre value.

Potassium phosphate fertilizers have not developed a strong commercial base, due mostly to high costs. In general, they are high in analysis and have low salt indices. Some are of high solubility and are used in preparing liquid fertilizers, while others are formulated with controlled solubility.

Potassium carbonate and **potassium hydroxide**, produced on a limited scale, are used in high-purity fertilizers for foliar application or other specialty uses. Their high cost has precluded widespread use as commercial fertilizers.

Potassium availability—Once applied, most potassium fertilizers solubilize and enter the soil solution. This solution potassium is subject to leaching by rainfall if not retained by the soil. Most sandy soils do not retain large quantities of potassium; so it must be applied on a regular basis.

Soil pH affects potassium retention. As the soil pH declines below 6.0, greater losses of applied potassium due to leaching are observed. At a soil pH of 4.5 or less, potassium retention is essentially zero. Thus, an appropriate liming program to maintain the soil pH at 5.5 or above is essential to optimize the efficiency of a potassium fertilization program.

In an unpublished field leaching study, I observed that—over a 112-day leaching period—potassium sulfate leached only about half as much total potassium as did potassium chloride (Fig. 3). Coating the potassium with sulfur did not influence the potassium loss due to leaching. Snyder and Cisar found no growth response, relative to source, for a number of coated potassium fertilizers.

Potassium sources influence the quantity of potassium available to the turfgrass. Horn reported that K_2SO_4 and K_2CO_3 were superior K fertilizer sources for bermudagrass compared to KCl and other potassium sources.

In light of the reduced leaching of potassium from K_2SO_4, its enhanced growth response, low salt index and high analysis, potassium sulfate is a very desirable source of potassium for turfgrasses.

Additionally, K_2SO_4 has the benefit of supplying sulfur. On occasion, applying K_2SO_4 produces a greening response, indicating a probable response to applied sulfur.

—Jerry B. Sartain is a turfgrass fertility consultant in Gainesville, Fla.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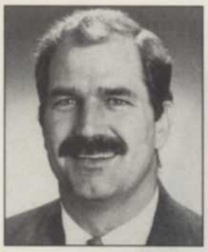
The *Poa trivialis* challenge



by Craig W. Edminster

■ Few in the grass seed industry, or among end-users for that matter, foresaw the exceptional and largely unfilled demand for *Poa trivialis* (rough bluegrass) in the 1991 overseed season.

The species has few of the bells and whistles which seed industry and turf research scientists said would be necessary for success in the early '90s.

Absent, for instance, are a definitive dehydration avoidance mechanism, *Acremonium* and *Epichloe* endophytes for increased insect resistance, and a dark green color.

Yet *Poa trivialis*, a cool-season perennial turfgrass, has quietly taken over a sizable portion of the market in regions where overseeding is a yearly occurrence.

It is no longer merely a specialized species for use on golf courses and moist, shady lawns. There is good reason to believe that, if production came closer to matching demand, it would seriously challenge the improved perennial ryegrasses as the grass of choice for winter overseeding.

Characteristics—*Poa trivialis* is a sod-forming perennial, adapted to cool, wet, shady areas.

It exhibits a moderately fine texture, is light green to green in color and characteristically has an extensive fibrous yet shallow root system.

The most significant market for *Poa trivialis* is as a specialty turfgrass in winter overseed blends and mixtures in the South.

Poa trivialis is intolerant of drought or moisture-stressed soils and will either enter temporary summer stress-induced dormancy or simply die.

Advantages—Here are some of the advantages offered by *Poa trivialis* in an overseeding program:

● **Transition:** *Poa trivialis* is considered to be an "easy transition" species. It can easily be eliminated by fertility/water management, cultural practices or naturally by summer- and warm-season-induced stress.

● **Reduced seeding cost:** *Poa trivialis* seed counts are in the neighborhood of 1.9 to 2.2 million seeds per pound, making for very cost-effective seeding rates. *Poa trivialis* used exclusively or in poly-species mixtures can save an estimated minimum of 20 percent on seed cost.

● **Maximized yearly rounds of play:** *Poa trivialis* can be sown and mowed extremely tight during and after germination. It is not uncommon to dethatch an existing permanent bermudagrass green, sow *Poa trivialis* and allow play the following day.

● **Low soil temperature tolerance:** *Poa trivialis* has shown it can germinate in soil temperatures ranging from 40° to 50° F rather effectively. Straight *Poa trivialis* as well as ryegrass blends containing it require considerably less hardening off and are, therefore, buffered from cold damage.

● **Competitiveness with annual bluegrass:** Winter overseeding with *Poa trivialis* can effectively reduce annual bluegrass (*Poa annua*) contamination by effectively competing for soil nutrients and sunlight. Similar growth habits, tolerance to low mowing, and preference to cool, wet soils of the two species make for excellent natural competition. As a result, populations of annual bluegrass may decline significantly over time.

● **Impressive stimpmeter readings:** Stimpmeter speeds of *Poa trivialis* overseeded greens are significantly faster than greens sown to straight perennial ryegrass. *Poa trivialis* can be managed to accentuate or lessen relative ball speed.

● **Non-competitive soil stabilization:** Golf superintendents, designers and contractors are often faced with land stabilization problems prior to finish grading and grass planting in temperate warm-season regions. When warm-season grass sprigging and seeding must be postponed until spring (when soil temperatures are optimal), *Poa trivialis* can be used as a non-competitive, reduced-maintenance winter overseed species.

● **Avoidance of iron chlorosis:** Under high alkaline conditions in Southwestern soils (pH greater than 7.5), *Poa trivialis* appears to have a tolerance to low soil iron levels, and will not exhibit yellowing or chlorosis unless under extremely high pH.

● **Soil nitrogen use:** *Poa trivialis* appears to be an excellent user of soil nitrogen when soil temperatures are very

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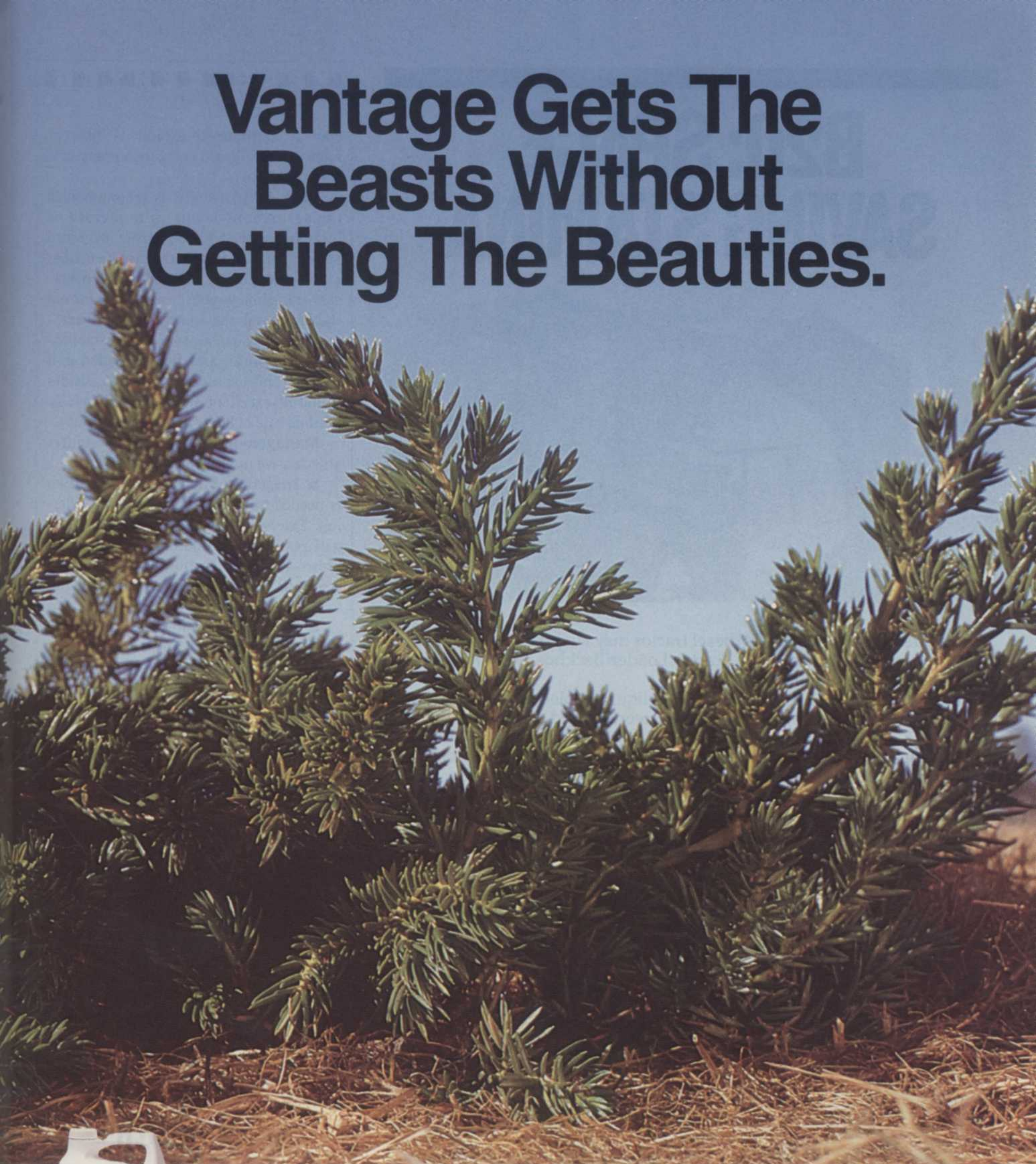
Use	Mixture: Poa trivialis	Perennial ryegrass	Chewings fescue	Kentucky bluegrass	Creeping bentgrass	Seeding rate (lbs./100 sq. ft.)
For shady lawns in cool, moist temperate areas	20%	20%	30%	30%		4
For intensely shady lawns in cool, moist, temperate areas	100%					2
Options for overseeding dormant warm-season turf on golf course greens and tees	100%					10-13
	15%	85%				25
	15%	60%	25%			25
	60%				40%	6-10

Source: the author



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cool. It continues to exhibit its inherent light green to green color under very cold soil conditions.

Uses—*Poa trivialis* is recommended for permanent lawns in moderate or intense shade, and for winter overseed blends and mixtures. It can also be used as a non-competitive, reduced-maintenance, easy-transition winter groundcover for soil stabilization in the South and Southwest.

Delayed warm-season grass establishment on rough and finish-graded golf courses and exposed irrigated roadsides would be excellent sites for *Poa trivialis*. Seeding rate of 80 to 120 pounds per acre.

Management—*Poa trivialis* requires an extensive management program:

- **Irrigation:** Supplemental irrigation is needed for dense and aggressive tillering. Extended periods of moisture stress will result in an unattractive purplish-brown leaf discoloration and, ultimately, death. Its roots respond favorably to light, frequent irrigations.
- **Fertilization:** Most desirable: split applications of a balanced fertilizer in moderate amounts with N-P-K ratios of 5-1-2. Applications should be made at establishment and during active fall and spring growth. Heavily shaded areas must be managed with greater nitrogen levels and higher cutting heights.
- **Mowing height:** *Poa trivialis* may be mowed at very low (9/64 to 3/16) heights when planted at very heavy rates on golf course greens and tees. It, however, prefers mowing heights in the range of 1/2 to 2 inches. Mowing higher than 2 inches results in reduced quality.
- **Weed control:** Phenoxy-based lawn chemicals can be used to control broadleaf weeds with excellent results. *Poa trivialis* also appears to be very compatible with annual bluegrass in heavily-contaminated and compacted soils.

—The author is Director of Research at International Seeds, Halsey, Ore.

Next Month's Cover Story:

Project Estimating and Analysis

A leading Boston-area landscape maintenance expert reveals how to start 1992 on the right foot: with more accurate job estimates.