SALT-TOLERANT GRASSES FOR ROADSIDES

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An accelerated use of sodium chloride and other salts for de-icing highways has caused widespread destruction of roadside vegetation. Satisfactory alternatives to salting have not yet been devised; thus the need for plants that are tolerant of a drastically changed environment must be considered. This discussion is limited to several grasses found in the United States, which have demonstrated good salt tolerance. Specific growth characteristics and habitats of the grasses pertinent to roadside use are discussed. Research with specific grasses is cited, and the need for further in-depth research and development with salt-tolerant grasses is noted.

•THE establishment and maintenance of roadside vegetation for aesthetic and utilitarian reasons date back many centuries. Better and more serviceable roads have become a prime factor in our current mode of living. Man's current ability to alter his environment—both physically and chemically—in the construction and maintenance of highways has brought about many serious plant problems. Among those to be considered in plant production are poor soil conditions with high- and low-moisture regimes and temperature extremes.

Salt damage to roadside plantings has become a critical problem in recent years. Large increases in the use of salt (primarily sodium chloride) for de-icing are continuously being reported. In Illinois, for example, the amount of salt used on all state-maintained highways during the winter of 1957-58 was 39,234 tons. This increased to 309,900 tons during the winter of 1969-70, which is an eightfold increase in 12 years. Dickinson (4) has reported comparable trends for the entire United States. Because there seems to be no immediate alternative to salt for de-icing, the difficulty of growing plants along salt-treated roads seems almost insurmountable. As reported by Hutchinson (11), the number of sodium and chloride ions is normally the highest near the roadway, decreasing with distance from the highway. Also, their number increases with the length of time that salting has been practiced. In Illinois the salt levels are often high in channels and depressions where runoff water stands.

Near the paved surface, where grasses are needed most for erosion control and stabilization (medians being especially vulnerable), the salt hazard is the greatest. It is in this critical area, where the vegetation disappears first, that the problem is most severe. Without vegetative cover, soil in the runoff water clogs sewers, causing back-up water to be a problem. With the demise of the vegetation, the exposed soil may be covered with concrete, asphalt, or gravel at great expense. This solution, besides being expensive and unattractive, may increase runoff so much that the drainage systems will be inadequate. Also, without soil to store the salt, at least temporarily, the entire application may rapidly find its way into the runoff water and thereby increase stream pollution.

The need for grasses known to have a high tolerance for salt should be considered for use where salt is (or potentially is) a problem. The use of salt grasses on saline areas should be considered a stopgap measure because salt levels would be expected to rise greatly with continued salting. Some highway areas are already too salty for the most salt-tolerant grasses.

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SALT-TOLERANT GRASSES

Literature Review

Although only limited research has been done in this area, there is general agreement about a relatively few grasses that seem to have good salt tolerance. It should be noted that the relative salt tolerance of the various grasses cited in the following paragraph was arrived at by using diverse techniques and methods of evaluation. It is not at all unusual to find a grass listed as having good, fair, or poor salt tolerance, depending of course on growing conditions, comparative grasses, and so forth.

Bernstein (1) listed the following grasses as having good salt tolerance: alkali sacaton (Sporobolus airoides), salt grass (Distichlis stricta), Nuttall alkali grass (Puccinellia nuttalliana), Bermuda grass (Cynodon dactylon), tall wheatgrass (Agropyron elongatum), Rhodes grass (Chloris gayana), rescue grass (Bromus catharticus), Canada wild rye (Elymus canadensis), western wheatgrass (Agropyron smithii), tall fescue (Festuca arundinacea), and barley (Hordeum vulgare).

Another source (15) substantiates Bernstein's list, except for tall fescue. Tall wheatgrass was not ranked. Branson (2) considered tall alta fescue to have only medium salt tolerance. Experience along Illinois roadsides that are salty has not shown tall fescue to have suitable salt tolerance. Forsberg (8) found tall wheatgrass to be a highly salt-resistant grass. Based on work by Lunt et al. (12) and Sanks (13), it is appropriate to add weeping alkali grass or spreading meadow grass (Puccinellia distans) to the list.

Grasses Suitable for Roadsides

Duell (7) has noted the need for special grasses for highways; he specifically mentions mowing and appearance. In addition to the potential height of the grass, there are several factors to consider in selecting and breeding roadside grasses. Longevity, method and speed of initial establishment, density of the sward (for erosion and weed control), type of seasonal grass, potential destruction by the grass to the road surface, potential as a weed, and climatic range are some of the more important considerations.

An examination of the grasses listed previously, for use along roadways where salt is or is expected to be a problem, points to the relatively few choices that are available.

Barley is a tall-growing annual that might be of some use as a "nurse" crop for establishing other salt-tolerant grasses. Thus, barley is limited for use along saline roadsides.

Rescue grass is a tall annual or biennial plant that grows primarily in warm regions. It is apparently of little use where roads are salted.

Rhodes grass is a tall perennial grass found in warm regions. It cannot be used in regions where highways would be salted.

Bermuda grass is a low-growing, rapid-spreading, warm-season grass that becomes dormant in cool weather during autumn and often does not "green up" until middle or late spring. The strong rhizomic habit of common Bermuda can cause pavement problems. Although the climatic range may extend well into the North, this grass does best in more southerly locations where de-icing is not too common.

Alkali sacaton (bunchgrass) is found throughout the West and normally is considered a bunchgrass. However, Griffiths et al. (9) reported two distinct types of growth: (a) a continuous uniform growth that approaches a turf and (b) a bunchgrass. As an open bunchgrass of moderate height, alkali sacaton would seem to be poorly adapted to roadside use, but as a "turf" it would have definite possibilities. More work and a better understanding of this grass are definitely needed.

Canada wild rye is a tall, upright, cool-season perennial bunchgrass. Hanson (10) reported that this grass is short-lived. The ability of this grass to persist along roadsides, where mowing is usually frequent and close, is questionable. However, its use in low, unmowed areas might be considered.

Tall wheatgrass is a tall, coarse, late-maturing bunchgrass that can be grown successfully on wet soils. Again, the ability to provide needed cover with frequent mowing

along roadsides would be questionable, but its use in low, unmowed areas might be considered.

Western wheatgrass (Colorado bluestem) is a relatively low-growing, cool-season grass that should tolerate highway mowing practices. Underground stems should give some protection from brine splash. Although this grass does best on low areas in arid regions, it will persist with very low rainfall and could possibly be useful, especially in mixtures, along roadsides.

Inland salt grass is a strongly rhizomatous, warm-season perennial found throughout the West, eastward to Iowa and Missouri. Although it is a low-growing grass, has exhibited excellent salt tolerance, provides a dense cover, and is found under quite droughty situations, it does have some distinct disadvantages. Because this salt grass is a warm-season grass, it becomes dormant during cold weather and could become a fire and weed problem. However, because it becomes dormant in the fall, inland salt grass may have a strong resistance to brine splash injury. Another disadvantage is that the strong rhizomes of this grass are frequently seen growing through paved surfaces. Also, this dioecious grass is a poor seed producer, and vegetative propagation is practiced. Extensive studies of salt grass have been made in Nebraska by Dudeck (5, 6). This grass has possibilities for roadside use, especially in areas where it is known to be growing wild.

Nuttall alkali grass (Puccinellia airoides) is a cool-season perennial that grows to a moderate height. It is found growing in the western states and in the northern part of the northeastern states. Griffiths et al. (9) reported that, when it is found, it is usually growing to the exclusion of everything else. They also reported that not only is it able to withstand large amounts of soluble salts in the soil, but also it will grow in situations where large amounts of soluble salts in solution stand on the ground for a month or more at a time. This is important because of the standing water in channels and on frozen soil along highways and because of brine splash. The seed head characteristics of Nuttall alkali grass and of weeping grass are generally similar to some common bluegrasses and are easily confused with them. In some of the early writings, alkali grasses were considered bluegrasses. Both alkali grasses are bunchgrasses. Both tiller vigorously and have unusual seedling vigor and provide quick cover. Both are dark green in color and seem quite promising for use on salty roadsides.

Spreading meadow grass (or weeping alkali grass) is a fine-textured, low-growing perennial grass. It is lower growing than is Nuttall alkali grass. It is a cool-season grass that is quite similar to Kentucky bluegrass (Poa pratensis) except that it is not rhizomatous. It has a rapid rate of tiller production, and under extremely poor soil conditions it has been found to have a good root system. This grass is found in many parts of Canada and the United States. Undoubtedly it now grows in many areas where it did not appear a decade ago, perhaps because of man's influence on the environment. This grass is found on golf course fairways in Colorado, forming dense turf at mowing heights of 1.5 in. or less. It seems promising for roadside use where the soil has a high content of salt.

There are several other alkali grasses that offer possibilities for use on roadsides in the north-central and northeastern United States.

OBSERVATIONS AND RESEARCH

An annotated bibliography on highway turf by Smithberg and White (14) points to the paucity of information on salt and alkali problems, especially when they are concerned with intricacies of roadside conditions. The following observations and research results seem pertinent to those faced with highway salt problems.

Observations in Illinois

For several years, salt has been causing noticeable vegetative damage along the highways in Illinois. In the spring of 1969, a group of Illinois highway maintenance supervisors and plant scientists from the University of Illinois held an advisory committee meeting and a tour of the Chicago Interstate System to assess the major vege-

tative problems. It was quite apparent that salt damage to the vegetation was a major problem. It was common, often for miles, to find the grass (standard highway mixtures) dead and the soil barren, especially in the median and 10 to 15 ft on either side of the road. However, at the intersection of US-45 and I-55, bunches of alkali grass (later identified as Puccinellia distans) were found growing near the pavement and in a drainage ditch. It seems most likely that the alkali grass was introduced at this site as a contaminant in the specification seeding; however, there are several other possibilities.

In 1969 and 1970 a search for alkali grass seed was undertaken. Small quantities of Nuttall and lemmon alkali grasses (Puccinellia lemmoni) were obtained for experimental purposes. At that time after extensive search, neither Nuttall alkali grass nor weeping alkali grass, the two grasses that seemed to offer the most promise for Illinois roadsides, was available in quantity.

By the spring of 1970, the weeping alkali grass at US-45 and I-55 had become established by reseeding itself to such an extent that sufficient seed could be harvested for experimental work. This alkali grass was most noticeable where the brine concentrated and flowed directly from the pavement onto the soil. The grass that had been originally planted had died, and most of the soil was exposed. During 1970, weeping alkali grass began to appear at a few locations along the Chicago Interstate System. By 1971, this alkali grass could be found to a limited extent along roadways outside Cook County in central and northern Illinois. A concentrated seed harvest effort in 1971 provided the needed seed to establish additional nursery plots for seed production. In 1972 sufficient seed for more extensive roadside testing and experimental work should be available.

It is of interest here to note a change in the roadside ecosystem in the Chicago area, which appears to be primarily a salt effect. The transition seems to be from Kentucky bluegrass and tall fescue to quack grass (Agropyron repens)—perhaps under some conditions quack grass sod should be used for stress areas—then to quack grass-alkali grass, and finally to alkali grass with some Mexican fireweed (Kochia scoparia) and orache (Atriplex patula). The latter two are annual broadleaf weeds that do not offer the erosion control or aesthetic qualities of alkali grass but are salt-tolerant.

Seed and Seedling Characteristics of Weeping Alkali Grass

Weeping alkali grass is a prolific seed producer, normally seeding at about the same height as Kentucky bluegrass. Seed size is similar to Kentucky bluegrass, and there are at least 2 million seeds per pound. In seed harvesting, timing is critical because there is a very short period between seed ripening and shattering. In the fall, the seed that has shattered and fallen to the ground germinates and forms a dense stand of young seedlings between normally isolated bunches. Also, the spread of the grass can sometimes be directly correlated with direction of water flow and mowing.

Research in Illinois

Because of the urgency of the roadside salt problem in Illinois, a crash program has been carried out. Much of the work that has been done needs to be repeated in more detail and on a larger scale.

It is not uncommon for grasses to show a positive growth response to low levels of sodium chloride in the soil. In greenhouse studies, the growth of alkali grass at 1 percent salt (by weight) in the soil was not noticeably affected. Even at 2 percent salt levels, growth was 80 percent normal, as compared with less than 60 percent for perennial ryegrass (Lolium perenne), Kentucky bluegrass, western wheatgrass, and crested wheatgrass (Agropyron cristatum) (3).

Weeping alkali grass seed that was collected in Illinois produced greenhouse-grown plants that were slightly more salt tolerant than Nuttall alkali grass and lemmon alkali grass from the West (3).

Because of the scarcity of weeping alkali grass seed and because of the adaptability of sod (established sod would be expected to have more salt tolerance than seedlings), a study was conducted by Sanks (13) to determine the mixture ratio of weeping alkali

grass and Kentucky bluegrass in order to produce a liftable sod. In less than a year, a mixture of weeping alkali grass and Kentucky bluegrass at a seeding ratio of 9 to 1 (by weight) had produced a strong, liftable sod. Even though the Kentucky bluegrass would tend to go out at high salt levels, it served to bind the sod and increased distribution of the limited quantities of alkali grass seed.

Early in the spring of 1971, weeping alkali grass-Kentucky bluegrass sod was lifted and moved to an area along the roadside at the intersection of US-45 and I-55 and along the sidewalks at the Illinois Highway Office Building where salt has been a problem. Along the roadside, the Kentucky bluegrass soon died out, but the alkali grass remained.

Direct foliar application of salt as spray from the highway has been of concern to those seeking salt-tolerant grasses. (Normally, soil or vegetative growth levels are used as the criteria for determining salt tolerance in plants.) Sanks (13) compared the damage caused by brine applications to two alkali grasses and two wheatgrasses. He made eight winter applications of a strong brine solution to well-established plants. The rate of salt application was equal to 42 tons of sodium chloride per lane-mile. Nuttall alkali grass and weeping alkali grass showed the least damage from the sodium chloride solution. Western and crested wheatgrasses were killed or seriously injured at this salt level.

Research in Colorado

At Colorado State University, J. L. Fults has made morphological comparisons of both Nuttall alkali grass and weeping alkali grass. One of the collections of weeping alkali grass (Accession-666) from the Boulder, Colorado, Country Club shows excellent turf characteristics and deserves further testing and study.

Another collection made by Fults exhibits a stoloniferous growth habit. If this feature is reproducible, and not a pseudo-characteristic, then progeny from this plant could provide more rapid establishment and cover than the bunch type alkali grasses now being considered for use.

RESEARCH AND EXPERIENCE NEEDS

The need for research and experience with plant problems associated with high levels of roadside salt is great. The information available on salt grasses has been gathered from diverse and often artificial situations. The complexity of situations along roadsides in urban areas makes it impossible to consider all of the variables, let alone devise a workable model. Consequently, the experience and technical knowledge of the plantsman will be quite beneficial whether tolerant species (either herbaceous or woody) should be considered. Some highways have been constructed such that initial establishment of grass in the median or near the pavement is sheer waste because the cover has declined and disappeared even without the presence of salt and with ideal care.

A few of the immediate needs that deserve attention are as follows:

1. Selection of individuals within the various species that have the highest salt tolerance; Dudeck (6) has noted that unclipped clones of salt grass differed significantly in their response to sodium chloride;
2. Development of better seeding and vegetative methods of establishing grasses in high salt areas; and
3. Study of seeding habits and commercial production of the seed of salt-tolerant grasses.

SUMMARY

The continued use of salt for de-icing has increased the need for salt-tolerant grasses that can be used on roadsides. Although there are several grasses that have shown good tolerance, only a few of these can be used for highway purposes. Because of the seriousness of vegetative destruction by salt and the resulting problems, continued research and development are needed.

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