ESTABLISHMENT OF BERMUDAGRASS SEEDED WITH ANNUAL RYEGRASS

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William J. Bowmer and Wayne G. McCully*

SUMMARY

The establishment and culture of grass often is hazardous. Areas planted to grass usually are not fallowed, so that grass seedlings succumb to weedy competition. Where competition is introduced by seeding aggressive annuals in the same mixture with perennial plants, it usually is necessary to limit the competition of the annuals in order to achieve a cover of the perennials.

Pre-emergence weed control has not been widely used in grass seedings. Paraquat on 1 pound per acre or dalapon at 15 pounds per acre successfully reduced the competition from annual ryegrass and substantially increased stands of bermudagrass. Dalapon, because of its residual effects, should be applied at least 30 days before the expected germination of desired grasses.

The results of this research should be projected to control volunteer weeds in a grass seeding, to control aggressive annuals from the seeding mixture in the transition from a temporary to a permanent cover, and to renovate established sods.

INTRODUCTION

Soil erosion is a serious hazard to a highway right-of-way lacking a protective cover of vegetation or other material. Approximately one-half of the unpaved portion of a right-of-way is composed of cut-and-fill slopes or other critical areas having steep grades (Hottenstein, 1963). Movement of soil from these critical areas produces siltation damage to nearby properties, reduces the usefulness of culverts and other structures and requires continual maintenance of the eroded slopes.

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On slopes flatter than 3:1, soil stabilization is generally obtained by using a vegetative cover. The Texas Highway Department presently uses bermudagrass (Cynodon dactylon (L.) Pers.) for slope stabilization in the eastern third of Texas. Bermudagrass can be established either by seeding or by sodding. Since sodding is several times more expensive, seeding is preferred if satisfactory stands can be secured.

Seeding mixutres for highway rights-of-way normally contain a base grass and a companion grass. The base grass is a long-lived perennial, such as bermudagrass, which is intended to become the permanent cover on the seeded area. In contrast, the companion grass is a quick germinating annual or a short-lived perennial, such as ryegrass. The companion grass is intended to furnish a quick cover for erosion control until the base grass becomes established. It is assumed that the companion grass will not compete with the base grass for light, nutrients and moisture.

THE PROBLEM

Bermudagrass is a warm-season plant, but it has been planted widely during the cooler months with annual ryegrass (Lolium multiflorum Lam.). A mixture of 12 pounds of unhulled bermudagrass seed and 15-30 pounds of annual ryegrass seed per acre commonly is used. The ryegrass is expected to serve as a temporary cover and to be replaced by a cover of perennial bermudagrass with the arrival of warm weather. Experience has shown that little or no bermudagrass is established when the seeding rate of ryegrass is greater than 20 pounds per acre.

The objectives of this study were to: (1) determine if annual ryegrass contains any substance that retards germination and subsequent growth of bermudagrass; (2) determine the effects of seeding various rates of annual ryegrass on the establishment of bermudagrass; and (3) evaluate cultural practices which may aid in the establishment of bermudagrass seeded with annual ryegrass.

REVIEW OF LITERATURE

Plant Inhibitors

Many plants contain natural substances which retard germination and/or seedling growth of other species. These substances have been found in seeds, leaves, stems, roots and underground runners of a number of grass species (Audus, 1963). Annual ryegrass was found to inhibit respiration, and thus growth, of timothy (Phleum pratenes L.) and barley (Hordeum vulgare L.) (Patrick and Koch, 1958). Natural substances produced in various parts of quackgrass (Agropyron repens (L.) Beauv.) plants are inhibitory to associated crop plants (Hamilton and Bucholtz, 1955; LeTourneau and Heggness, 1957; Osvald, 1947; Welbank, 1963). Ryegrass is believed to contain about the same quantity of toxin as quackgrass per unit weight of dry matter (Welbank, 1963).

Plant Competition

When two or more plants grow together, they compete with each other. There is competition between the bermudagrass plants themselves, as well as between the bermudagrass and the companion grass plants. Companion plantings and other seeding mixtures have been used for a number of years with varying degrees of success. Much remains to be learned, however, concerning formulation of seeding mixtures using plants assumed to be compatible.

Companion plantings of both small grain and ryegrass greatly suppressed the growth of permanent grasses in seeding mixtures (Cullen, 1964a and 1964b; Crocker and Martin, 1964). Blaser et al. (1956) classed annual ryegrass as a very aggressive species and recommended that it be seeded at a relatively low rate. Erdmann and Harrison (1947) found that ryegrass dominated the cover when it made up 20 percent or more of the seeding mixture. They noted that, where a quick cover was not needed, seeding the permanent grass alone gave a more satisfactory turf than mixtures containing aggressive companion grasses.

Cultural Treatments

Establishment of a quick cover is essential to stablize critical areas on highway rights-of-way. Mowing reduces competition from the companion grass. Herbicides that selectively control certain grass species may be useful. Trichloroacetic acid (TCA), 2,2-dichloropropionic acid (dalapon), and 1,1-dimenthyl-4,4-bipyridinium salt (paraquat) have controlled competition in new grass seedings (Jones, 1962; Cuthbertson, 1964; Kay, 1964 and 1966; Allen, 1965; and Vengris, 1965).

PROCEDURE

Plant Inhibitors

A laboratory study was conducted to determine whether annual ryegrass plants contained a substance which retards germination of either bermudagrass or green sprangletop (Leptochloa dubia (H.B.K.) Nees.) seed. Cold water extracts were made from both green foliage and root material of annual ryegrass plants having three or five leaves and from annual ryegrass seed. Fifty grams of plant material were added to 150 milliliters of distilled water and extracted with a Waring blender. Three concentrations of each extract were compared with a distilled water standard in a germination study. The concentrations used were (1) no dilution; (2) one volume of extract diluted to five volumes with distilled water; and (3) one volume of extract diluted to ten volumes with distilled water. The germination test was conducted as a completely random design, and each treatment was replicated four times. Bermudagrass seed was germinated in alternating temperatures of 35° C. and 20° C., while green sprangletop seed was subjected to 30° C. and 20° C. alternations for the respective 8- and 16-hour day and night periods. These are the specified temperature regimes for germination of these grass species (U.S. Dept. Agr., 1952).

Plant Competition and Cultural Treatments

A field experiment was conducted to: (1) determine the effects of various seeding rates of annual ryegrass on the establishment of bermudagrass and (2) compare bermudagrass stands following the application of different cultural treatments to the ryegrass.

Soil on the study area was severely eroded Edge fine sandy loam (Mowery et al., 1965) with the subsoil exposed. The subsoil, a slowly permeable clay, together with the general 4:1 slope of the site, closely parallels the situation often encountered when seeding critical areas on seedbed preparation consisted of such weedy species as three-seeded croton (Croton lindheimerianus Scheele var. lindheimerianus Scheele), hairy crabgrass (Digitaria sanguinalis (L.) Scop.) and threeawns (Aristida spp.).

The area was tilled approximately 6 inches deep with a pulvi-mixer, then seeded with 12 pounds per acre of unhulled giant bermudagrass (NK-37) seed. Zero, 5, 10 or 20 pounds per acre of annual ryegrass was overseeded immediately on the bermudagrass planting. The seeding was completed December 22-23, 1964. The entire area was fertilized with 400 pounds of 16-20-0 per acre. Because ryegrass growth adequate for erosion control was anticipated, no mulch was applied.

Eight cultural treatments (Table 1) were applied on two dates to each of the four seeding rates of annual ryegrass. The first treatment was imposed when the ryegrass plants were 6-8 inches tall. The second treatment was made when the ryegrass plants were in the boot stage just before heading.

In the field experiment a split-split plot design was used, with four replications assigned by location on the slope. The main plots were the rates of ryegrass seeded, and the subplots were combinations of cultural treatments and dates of application. Measurements included counts of annual ryegrass and bermudagrass seedlings, estimates of percent green cover and frequency of established bermudagrass plants. These data were submitted to an analysis of variance.

RESULTS AND DISCUSSION

Plant Inhibitors

Extracts made from the various parts of ryegrass plants stimulated germination of bermudagrass seeds but not green sprangletop, even though the germination patterns were similar for the two grasses.

Simulation of germination of bermudagrass seed under laboratory conditions varied depending upon the part of the ryegrass plant from which the extract was made (Table 2). All seed extracts and the most dilute foliage extracts were less stimulatory than those from roots and the more concentrated foliage extracts. The lowest germination for both species consistently occurred in the distilled water control.

Results of this and earlier studies (Patrick and Koch, 1958; Welbank, 1963) indicate that water extracts from ryegrass affect individual grasses differently. Depending upon the grass species involved, extracts from ryegrass may stimulate, inhibit or have no effect on germination. Substances which stimulate growth also may inhibit growth at higher concentrations. The results of this study do not indicate the level of concentration that these extracts would become inhibitory to bermudagrass and green sprangletop. However, accumulation of these substances in the soil would be unlikely in view of their apparent water solubility. Since ryegrass does not contain a natural inhibitor to germination of either bermudagrass or green sprangletop, other factors must be responsible for the difficulty in obtaining a stand of bermudagrass when seeded with annual ryegrass.

Competition and Cultural Treatments

The competitive nature of annual ryegrass noted by Cullen (1964a and 1964b) and by Blaser *et al*. (1956) was confirmed by the field seeding. Increasing the

seeding rate of annual ryegrass increased the number of ryegrass seedlings but decreased the percentage of surviving seedlings (Figure 1). At the 5-pound rate, 60 percent of the seeds germinated and survived as compared with 50 percent and 42.5 percent at the 10- and 20-pound rates, respectively. The differences in ryegrass cover obtained from different rates of seeding were visually evident at the time the seedling counts were made (Figure 2). The intense competition within the ryegrass populations (Figure 1) indicated the stress to be placed on later germinating bermudagrass seedlings.

The effects of ryegrass seeding rate, cultural treatments and dates of treatment on germination and growth of bermudagrass were measured by numbers of bermudagrass seedlings per unit area (density). Neither the rate of ryegrass seeding nor the application of cultural treatments affected the stand of bermudagrass seedlings. All factors considered, the best bermudagrass seedling stands were obtained in the absence of both ryegrass and herbicides except with the low rate of sodium TCA (Figure 3). At the high rate of TCA, few seedlings were found. Where ryegrass was present, bermudagrass density was increased by treatment with either dalapon or paraquat. Rate of ryegrass seeding had no consistent effect on the results of the herbicide treatments (Figure 3).

Stands of established bermudagrass, based on presence or absence (frequency) of growing plants within the designated sample areas, were measured in October. In general, the stands of established plants had a pattern similar to that exhibited by the seedling stands approximately 3 months earlier. Generally, the plots neither seeded to annual ryegrass nor treated with herbicides continued to support the best stands of bermudagrass.

Established plants were found in greater frequencies on the flatter slopes than on the steeper side slopes. This difference probably was the result of a better moisture supply on the flatter slopes.

Frequencies of established bermudagrass varied with the cultural treatment imposed (Table 3). Few plants were found following treatment with either rate of sodium TCA (Table 3; Figure 4). Mowing and the high rates of dalapon or paraquat produced the best stands (Table 3).

Superimposing cultural treatment upon seeding rate of ryegrass gave variable results with respect to bermudagrass stand. Where herbicides were not used, ryegrass seeding at all rates drastically reduced the stand of bermudagrass. Except for both rates of sodium TCA and the lower rate of paraquat, the establishment of bermudagrass was enhanced by herbicide treatment (Table 3). The best stands, however, were not associated with any particular seeding rate of ryegrass. Bermudagrass stands on plots treated with the high rate of either dalapon or paraquat were comparable to those obtained where neither ryegrass nor herbicides were used (Figure 4).

Paraquat reportedly loses its herbicidal activity upon contact with soil particles (Jones, 1962). According to Warboys and Ledson (1965), however, it retained its activity when applied to grass mulch and retarded grass seed germination. In this study, paraquat reduced bermudagrass stands only at the high rate of ryegrass seeding (Figure 4). Although paraquat has been considered superior to dalapon for use on new grass seedings (Jones, 1962), the results of this study show little difference.

Visual estimates of the percent green cover on each plot made at the same time bermudagrass seedlings were counted provided an index for comparing the competitive effect of different rates of ryegrass seeding and the severity and residual character of herbicide treatments. Again the flatter slopes supported a greater amount of green cover than did the steeper slopes. This was further evidence of better soil moisture conditions near the toe of the slope. The importance of timing in applying cultural treatments was demonstrated by the higher percent green cover resulting from the early date of herbicide application.

All rates of ryegrass markedly reduced the weed population. Where ryegrass was seeded, there was little difference in total cover (Table 4) regardless of seeding rate. Shultz and Biswell (1953) showed that foliar densities of ryegrass became maximum at the seeding rate of 9 pounds per acre. This would account for the consistent similarity of estimates of percent green cover under the various seeding rates of ryegrass (Table 4).

The decline in percent survival of ryegrass plants with increasing rate of seeding (Figure 1) and the severe reduction in stands of both bermudagrass and weed plants where ryegrass was seeded (Table 4) illustrate the extremely competitive nature of ryegrass. Weaver and Clements (1938) and Plummer (1943) pointed out that competition for both water and light is critical during seedling development. Bermudagrass, a sun-loving plant, is very intolerant of shade. Besides competing for soil moisture, an established stand of ryegrass forms sufficient shade to be detrimental to bermudagrass seedlings.

Cultural treatments affected the green cover estimates in different ways. Sodium TCA acted as a temporary soil sterilant (Table 5). Both rates of dalapon gave less total green cover than did the two rates of paraquat, but the best stands of established bermudagrass were obtained with the high rate of dalapon (Table 3).

SUMMARY AND RECOMMENDATIONS

Seedling of perennial grasses often are subjected to intense competition and fail to establish a stand. This competition may come from weeds present in the seeded area or from other components of the seed mixture.

Competition between plants on the same site may arise from demands for moisture or from normal plant metabolic materials present in the soil (inhibitors). In this study involving annual ryegrass and common bermudagrass, the problem of establishing bermudagrass in a ryegrass sod seems to be one of available moisture and excessive shading. Bioassay with various fractions of ryegrass failed to show any active inhibitors.

The results of this study suggest application to problems in establishing turfs on roadsides as well as manipulating pasture forages. The highway engineer can successfully plant a mixture of annual ryegrass and unhulled bermudagrass in the eastern portion of Texas. Planting this seed mixture in late summer and fall will give him the benefit of soil protection from the annual ryegrass until the bermudagrass germinates the following spring.

A single application of 1 pound per acre of paraquat prior to March 1 or 15 pounds per acre of dalapon prior to February 15 should suppress the ryegrass sufficiently for the bermudagrass to germinate and become established. Mowing was equally effective, but systematic mowing of the ryegrass stand is required.

Application of these findings are equally promising for agricultural enterprises. A field being converted from a cash crop to pasture usually is not subjected to the intensity of fallowing which precedes cropping. Seeds of most perennial grasses do not germinate as quickly as annual weeds, nor do they develop as rapidly in the seedling stage. Application of the paraquat or dalapon in a band over the seeded row should suppress the competition from these weedy plants and permit the establishment of a stand of forage grasses. The sprayed weeds would, in effect, function as a short-term "dead-litter" cover crop until the grass seedlings become established. This practice will eliminate the need of fall-sown sorghum and the subsequent planting of grasses the following spring.

Although not tested in this work, a number of innovations are suggested in the management of existing stands. Timing the application of these materials is extremely important in achieving these selective actions. Paraquat functions primarily as a contact herbicide, so that the desired plants should be dormant at the time of treatment. Paraquat is much more expensive to use than 2,4-D presently, but it could be used where grassy weeds are a problem. Dalapon is a systemic material, but it also should be applied before the desirable species begin to grow. Either of these materials could be used to suppress competing annuals and favor the desirable perennial forage grasses in a pasture.

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TABLE 1. Cultural treatments applied to each seeded rate of annual ryegrass

Cultural treatments	Rate per acre, pounds	Volume Per acre, gallons	X-77 Surfactant, percent by volume	1965 Date 1	1965 Date 2
Sodium TCA	50	100		4/13 - 15	4/30 - 5/1
	100	100		4/13 - 15	4/30 - 5/1
Dalapon	7.5	40	0.2	4/13 - 15	4/30 - 5/1
	15.0	40	0.2	4/13 - 15	4/30 - 5/1
Paraquat	0.5 AI	100	0.1	4/13 - 15	4/30 - 5/1
	1.0 AI	100	0.1	4/13 - 15	4/30 - 5/1
Mow (2-inch stubble)				4/15	5/1
Check					

TABLE 2. Effect of ryegrass extracts on germination of bermudagrass (Underlining indicates grouping by Duncan's multiple range test).

	Source and strength of ryegrass extract									
	Distilled water	Seed 1/10	Foliage 1/10	Seed 1/5	Seed full	Roots 1/5	Roots 1/10	Roots full	Foliage full	Foliage 1/5
Percent bermudagrass germination	71.75	77.00	80.25	81.50	83.50	84.00	84.50	85.50	86.00	87.50

TABLE 3. Effect of various cultural treatments on established stand of bermudagrass (Underlining indicates grouping by Duncan's multiple range test).

	Cultural treatment							
	100 lbs. TCA	50 lbs. TCA	0.5 lbs. Paraquat	Check	7.5 lbs. Dalapon	1.0 lbs. Paraquat	Mow	15 lbs. Dalapon
Established bermudagrass Percent of frames containing bermudagrass	1.0	2.0	6.0	7.0	8.0	9.0	12.0	14.0

TABLE 4. Percent green cover as influenced by ryegrass seeding rate (Underlining indicates grouping by Duncan's multiple range test).

	Seeding rate of ryegrass			Pounds per acre
	10	20	5	0
Average percent green cover	8.5	9.8	10.1	26.3

TABLE 5. Effect of various cultural treatments on percent green cover (Underlining indicates grouping by Duncan's multiple range test).

	Cultural treatment							
	100 lbs. TCA	50 lbs. TCA	15 lbs. Dalapon	7.5 lbs. Dalapon	Check	Mow	0.5 lbs. Paraquat	1.0 lbs. Paraquat
Percent green cover	2.0	2.5	12.5	13.9	15.3	18.5	19.3	23.9

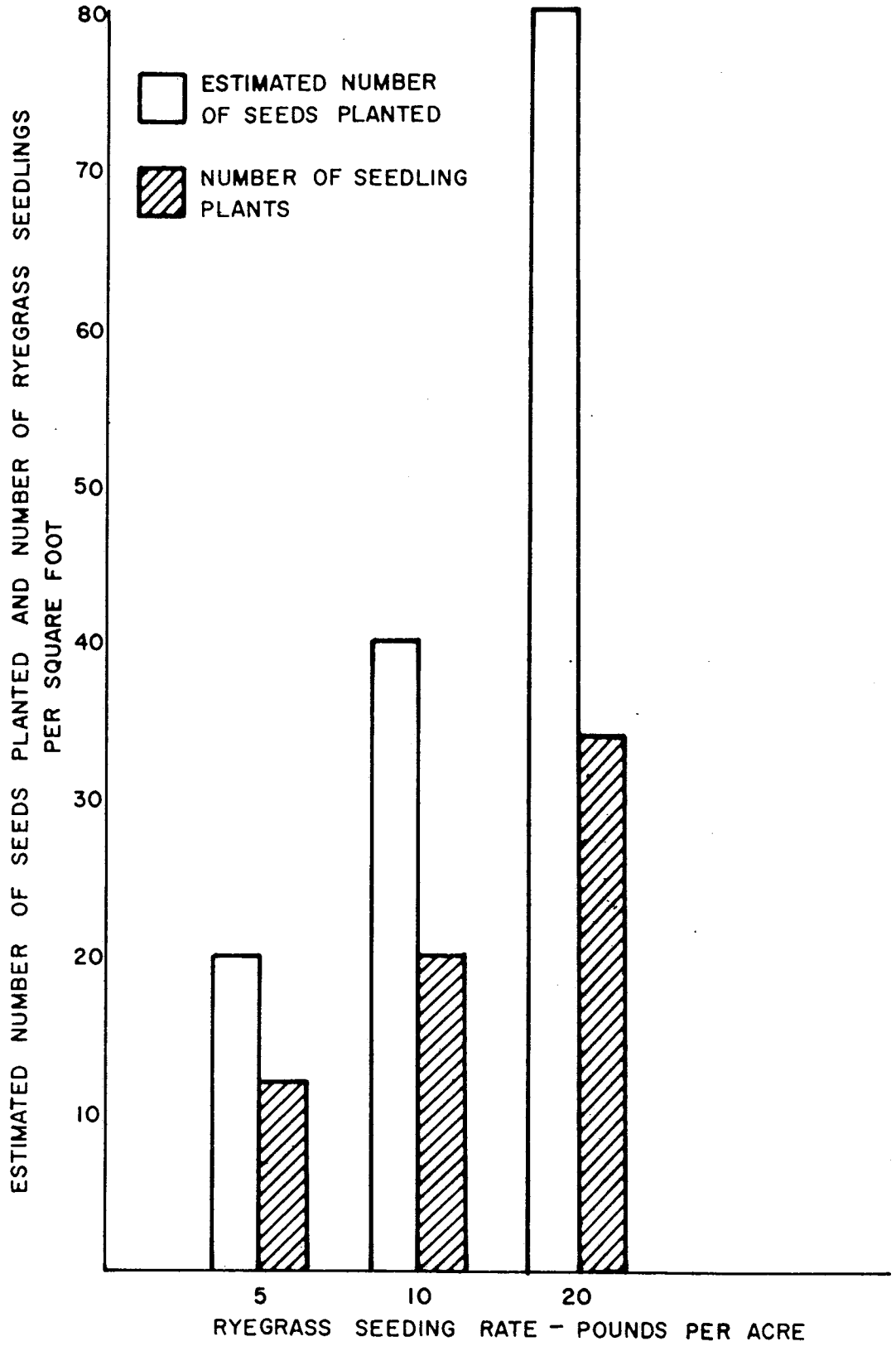

FIGURE 1 RELATIONSHIP OF THE NUMBER OF RYEGRASS SEEDLINGS AND ESTIMATED NUMBER OF SEEDS PLANTED PER SQUARE FOOT FOR SEVERAL RATES OF SEEDING.

Figure 2. The large stake near the center of the picture is a common corner for four rates of ryegrass seeding. The relative seedling stands obtained with 0 pounds per acre rate are in the upper right; the 5-pound per acre rate is lower right; the 10-pound per acre rate is upper left; and the 20-pound per acre rate is lower left.

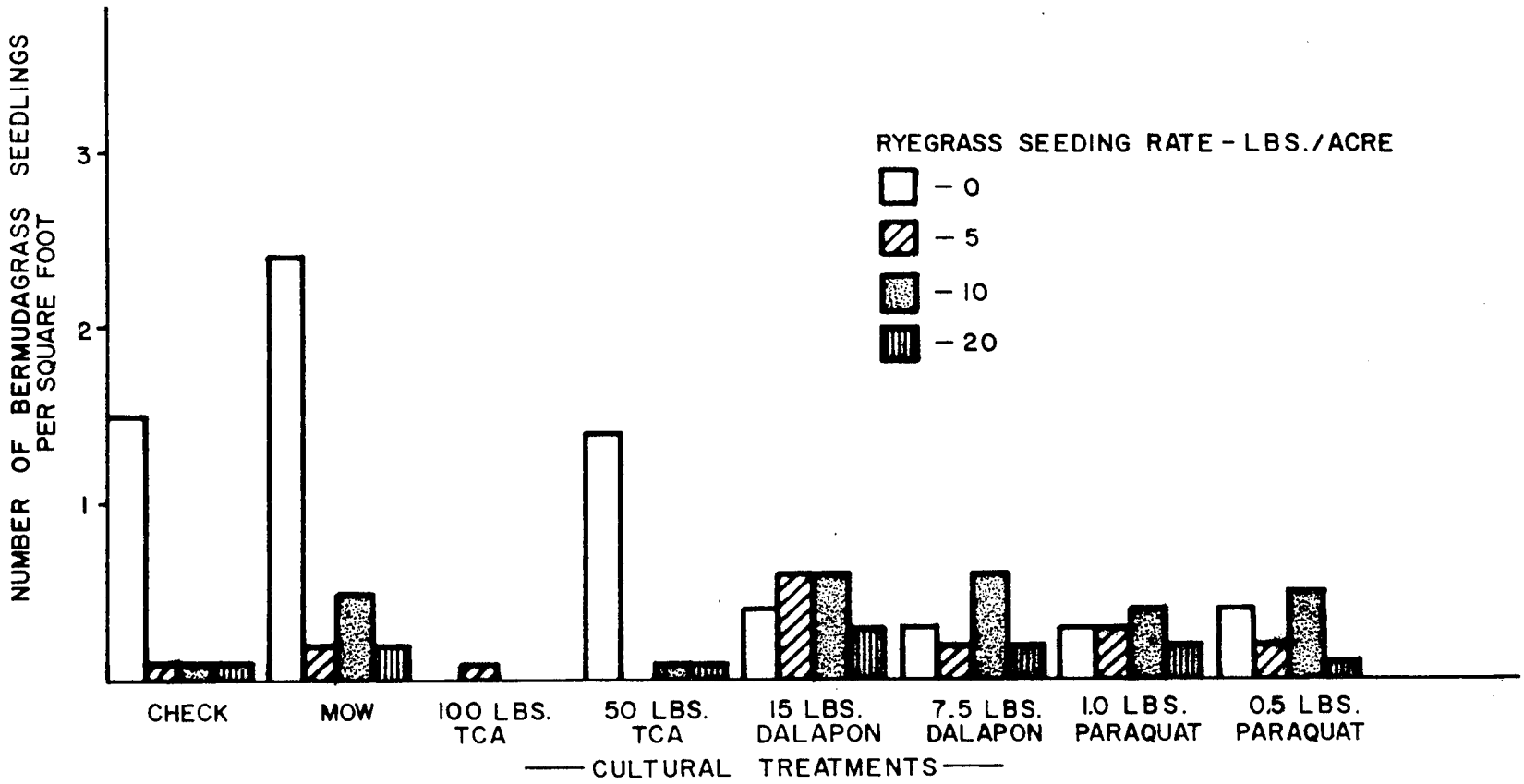

FIGURE 3 STANDS OF SEEDLING BERMUDAGRASS PLANTS AS INFLUENCED BY VARIOUS CULTURAL TREATMENTS AND SEVERAL RATES OF RYEGRASS SEEDING.

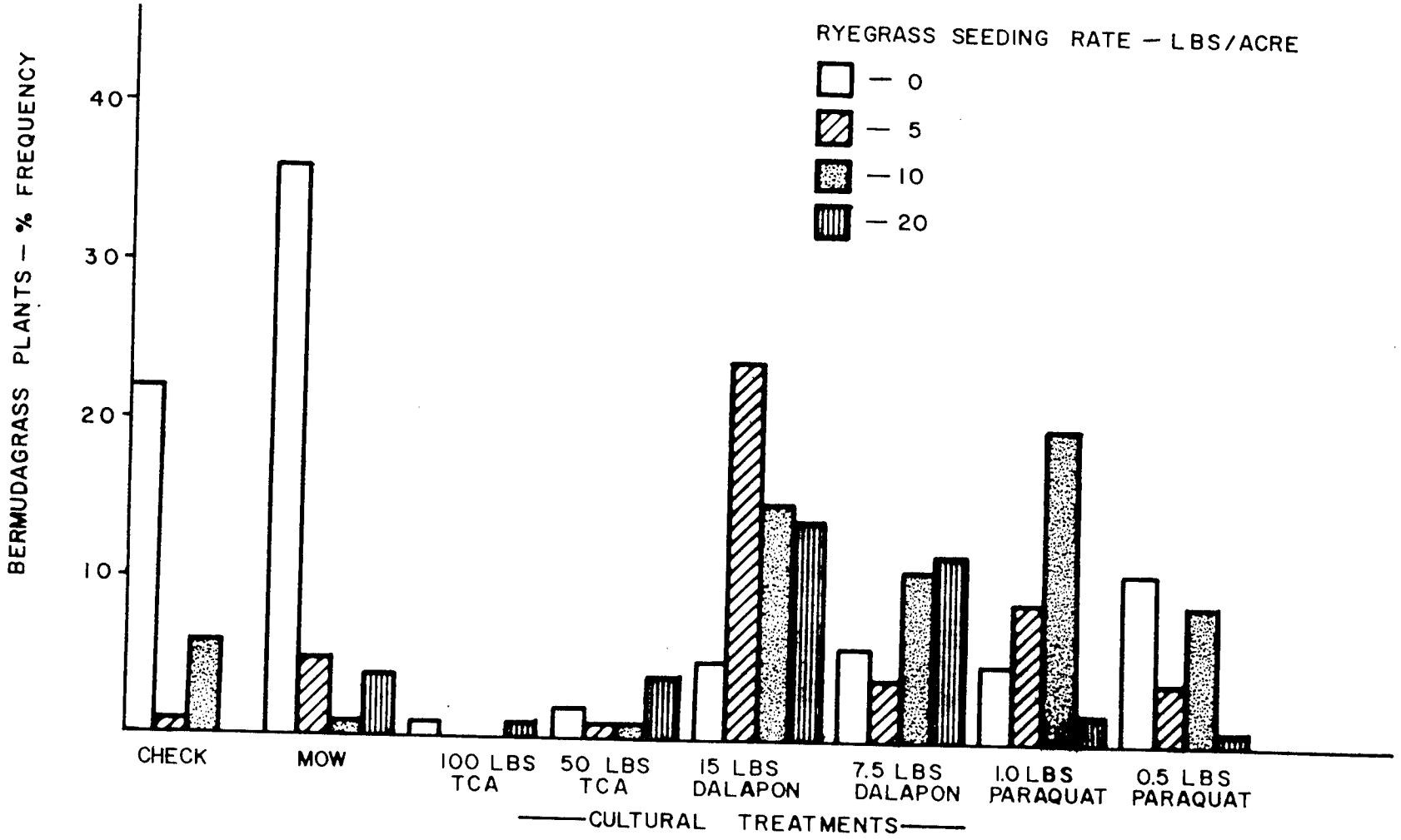

FIGURE 4 FREQUENCY OF ESTABLISHED BERMUDAGRASS AS INFLUENCED BY VARIOUS CULTURAL TREATMENTS AND SEVERAL RATES OF RYEGRASS SEEDING.