COMPETITIVE RELATIONSHIPS OF ANNUAL RYEGRASS (*LOLIUM MULTIFLORUM* LAM.)

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Abstract. Annual ryegrass (*Lolium multiflorum*) competition with Kentucky bluegrass, hardinggrass, Blando brome, wild oats, tall fescue, rose clover, and with itself was studied in greenhouse and field experiments. Ryegrass in a mixture of species always had a detrimental effect on the growth of other species. It did not furnish the usual advantages to other species which occur from a nurse crop or from litter. Annual ryegrass exhibited self-interference when grown in various combinations and densities.

Introduction

Annual ryegrass (*Lolium multiflorum* Lam.), a favored grass species for sowing in many temperate regions of the world, is used for planting in irrigated pastures and turf, overseeding on dormant turf during winter months, seeding on rangelands and dry pastures, and scattering from aircraft as an emergency cover for mountain areas burned by wildfires in California. Certain characteristics make it a good choice for the above uses. It has a high degree of seedling vigor and a fast rate of growth, grows well at relatively low temperature, produces abundant palatable forage and an extensive root system, gives a good green color to planted areas, and the seed is relatively inexpensive. However, several undesirable qualities of the species must be borne in mind. Its annual habit presents problems since annual ryegrass often will not persist in areas where it is seeded even though abundant seed is produced. The nitrogen requirement is relatively high and additional nitrogen must be supplied when soil nitrogen is inadequate. A third and important characteristic of annual ryegrass that can be undesirable is its high degree of interference with other species in a seed mixture or with those present in an area to be seeded. This quality may be the result of either its fast rate of growth or its release of some inhibitory chemical material that interferes with the growth of other species, or possibly both.

Numerous workers report the results of including annual ryegrass in a seed mixture or of its presence as a cover crop before seeding other pasture species. Charles (1962, 1964, 1965) found that the yield of forage clovers in a moist climate was consistently less when established with ryegrass than without ryegrass or with less aggressive species, regardless of methods of management. The production of unsown species (weeds) was also lower in the presence of ryegrass than with tall fescue (*Festuca arundinacea*). Survival of annual ryegrass in a mixture with two cultivars of perennial ryegrass (*L. perenne*) decreased from 80% to 4% in 3 years, thus suggesting the inability of annual ryegrass to persist in competition with other species when annual seedling establishment was necessary.

Schultz and Biswell (1952) studied interference between annual ryegrass and three perennial grass species (*Phalaris tuberosa, Festuca arundinacea,* and *Oryzopsis miliacea*) reseeded on burned brushland. They found that higher seeding rates of annual ryegrass decreased yields from the perennials more than could be recovered by higher seeding rates of the perennials. Studies of competition between annual ryegrass and seedlings of chaparral species showed that the early, vigorous growth of annual ryegrass depleted the soil moisture near the surface which is required for survival by the chaparral seedlings that do not germinate until later (Schulz, Kaunchbaugh, and Biswell 1955, Gartner, Schultz, and Biswell 1957). Without late rainfall, most of the chaparral seedlings die. The application of nitrogen increases top growth while decreasing root development of annual ryegrass which further depletes soil moisture near the surface and increases chaparral seedling mortality (Gartner et al. 1957).

The purpose of this study was to observe under controlled conditions the effects of interference by annual ryegrass on species seeded with it or on species that are native in areas where annual ryegrass is sown. Tests were carried out both in the greenhouse and in the field.

Experimental Data

Greenhouse tests

Annual ryegrass, Kentucky bluegrass (*Poa pratensis*), hardinggrass (*Phalaris tuberosa* var.

stenoptera), Blando brome (*Bromus mollis*), and wild oats (*Avena fatua*) were planted in monospecific (12 seeds per pot) and bispecific (6 seeds per species) combinations in 15-cm clay pots in the greenhouse. Four replications were planted and arranged in a completely randomized block design. Pots were irrigated daily, and each week they were irrigated with a standard greenhouse nutrient solution. At the maturity of wild oats all species in each pot were rated for vigor on a 1–5 scale. The plants were then harvested and the number of plants, height, and yield of each species in each pot were recorded. Plant weights from monospecific pots were divided by two for comparison with weights from plants in bispecific combinations. Data were statistically analyzed and the Duncan multiple range test was applied to the mean yields for monospecific and bispecific combinations.

The degree to which the competing species suppressed growth of test species varied considerably (Fig. 1). The order of these competitive effects was as follows: wild oats > ryegrass > Blando brome > hardinggrass > bluegrass. In general, the competitive effect of each species was significantly different (5%) from all others except adjacent species in the above ranking. Their specific effect on separate test species can be seen in Fig. 1. Another aspect of interference was observed when each species was grown with itself. Here it was found that ryegrass produced less when growing alone than when growing with any other species except wild oats. In this experiment wild oats and annual ryegrass produced significantly larger plants than any other species regardless of the planting combinations (Fig. 1). This in itself is a large factor in their success as aggressors since a rapid increase in size is important in dominating a given microenvironment.

Ryegrass plants produced a greater mass of surface roots than any of the other grasses (Fig. 2). This mat was extremely dense and extended completely through the pot. None of the other species appeared to produce roots at the surface. However, none of them had such a dense cover of top growth which served to protect the surface roots.

Competition in broadcast-seeded field plots

Field plots, 3.7 m square, were seeded in October to monospecific, bispecific, and polyspecific combinations of Blando brome, Kentucky bluegrass, hardinggrass, and annual ryegrass. Each species was planted alone and also seeded with ryegrass. In one plot all species were seeded to-

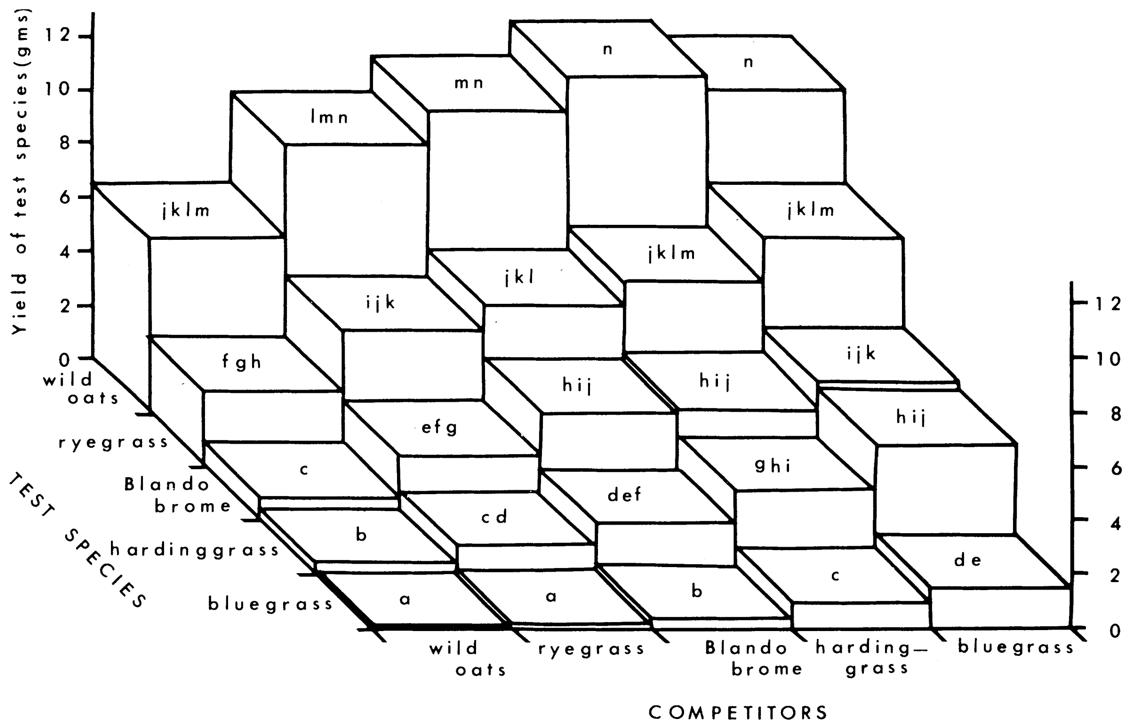

FIG. 1. Growth of test plants in monospecific and bispecific combinations. Each column represents the average yield per pot of the test species listed at the left of each horizontal row (of columns) when grown in combination with the competition species listed in front of the rows running front to back. Weights of species grown by themselves are divided by two for comparison with the other weights since they represent twice as many plants. Blocks lettered with the same letter are not significantly different from each other at the 5% level.

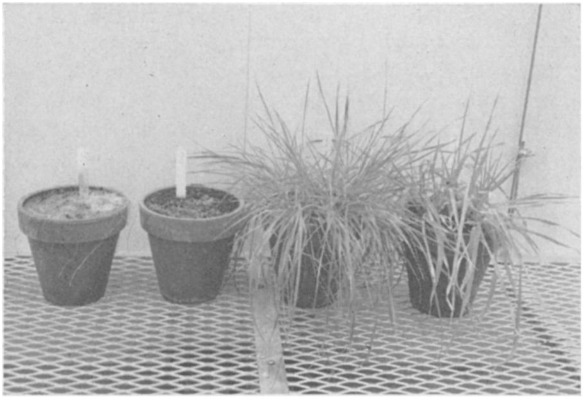

FIG. 2. Annual ryegrass and hardinggrass plants grown in monospecific arrangement (left to right, clipped ryegrass, clipped hardinggrass, ryegrass, hardinggrass). Note the mat of surface roots produced by the ryegrass plants (far left).

gether. The aggregate total seeding rate was 13.5 kg/hectare. Seeds were broadcast over the plots and very lightly raked for coverage. The eight seed combinations were replicated four times. Natural rainfall of 313 mm provided the only water during the winter and spring growing season. The ovendry weight at maturity of 10 randomly selected plants of each species in each plot was used as a measure of success in the association.

Not all species reacted alike to the interference offered by mono-, bi-, or polyspecific combinations in the broadcast-seeded plots (Fig. 3). As in the greenhouse tests, ryegrass was suppressed more by itself than by any other species or combination of species and was most productive when grown with bluegrass. Brome grass plants were approximately equal in weight in all of the species combinations. Hardinggrass showed the greatest

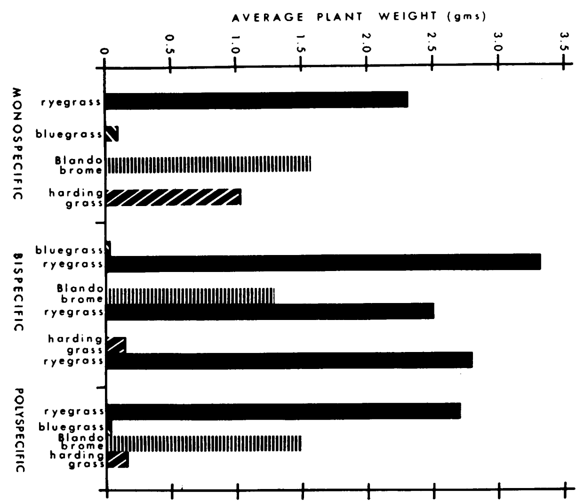

FIG. 3. Average weight of field grown plants sown in monospecific, bispecific, and polyspecific combinations.

effects of interference. Its size was reduced about six-fold by interference in the bispecific and polyspecific plots as contrasted with the monospecific plots. Bluegrass plants were extremely small in all cases but showed a further decrease when interference increased from monospecific to the other combinations.

Growth in row and open field plantings

Annual ryegrass was drill-planted in rows 3 m long and spaced 9 cm apart. Blando brome, Kentucky bluegrass, tall fescue (*Festuca arundinacea*), hardinggrass, rose clover (*Trifolium hirtum*), and wild oats were interplanted in separate rows between the rows of ryegrass but also extended 3 m beyond the ryegrass rows. Four replications were planted. In December, while the plants were fairly young, measurements were made of the crown spread and the height of three plants of each species growing between rows of ryegrass and growing in the absence of ryegrass. At maturity five plants of each species under the two ryegrass proximity conditions were harvested and weighed.

During the winter months the growth of test species planted between rows of annual ryegrass was considerably less than growth of the same species planted beyond the ryegrass rows. Contrary to observations in other plant associations there was no beneficial "nurse crop" effect from the ryegrass. In particular, early growth of rose clover and wild oats appeared to be suppressed when near annual ryegrass. The dry weights of test species at the end of the growing season were significantly smaller for those grown in the proximity of ryegrass than those grown in the open area (Fig. 4). Plant weights averaged less than half as much when under the influence of ryegrass.

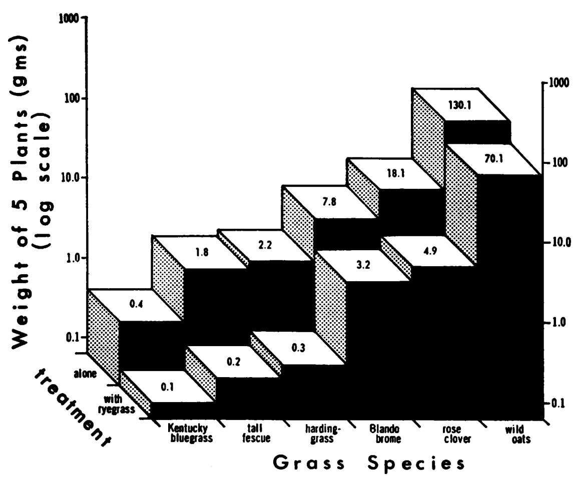

FIG. 4. Average weight of plants grown between rows of annual ryegrass and of plants grown in the open.

Effects of ryegrass litter on growth in the field

Five treatments were included in this 2-year experiment: (1) no ryegrass, (2) ryegrass litter remaining on plot, (3) ryegrass litter burned, (4) ryegrass litter cut and removed, (5) no previous plants of ryegrass but the plot receiving litter from treatment four. Four replications of annual ryegrass were drill-planted in three of the five 3.7-m by 3.7-m plots. The ryegrass was grown to full maturity and left until the next year. Then in the summer the residue was burned on treatment 3, and the residue from treatment 4 was removed and placed on plots of treatment 5. In the fall before any rain, all of the plots were seeded with equal amounts of rose clover and hardinggrass based on 6.7 kg/hectare (6 lb/acre) per species. (This rate would be considered excessive for hardinggrass under normal range-seeding practices.) Early in the growing season five plants of each species were harvested at random from each treatment and were dried and weighed. At maturity plots were rated for species dominance.

Annual ryegrass litter remaining from the previous year's growth had a significant influence on species composition in plots the following year (Fig. 5). Where the annual ryegrass residue was burned the plant composition appeared to show the greatest difference from other treatments. Ryegrass, rose clover, and filaree (*Erodium botrys*) were about equal in occurrence. There was more clover and less ryegrass on the burned plots than on plots of any other treatments.

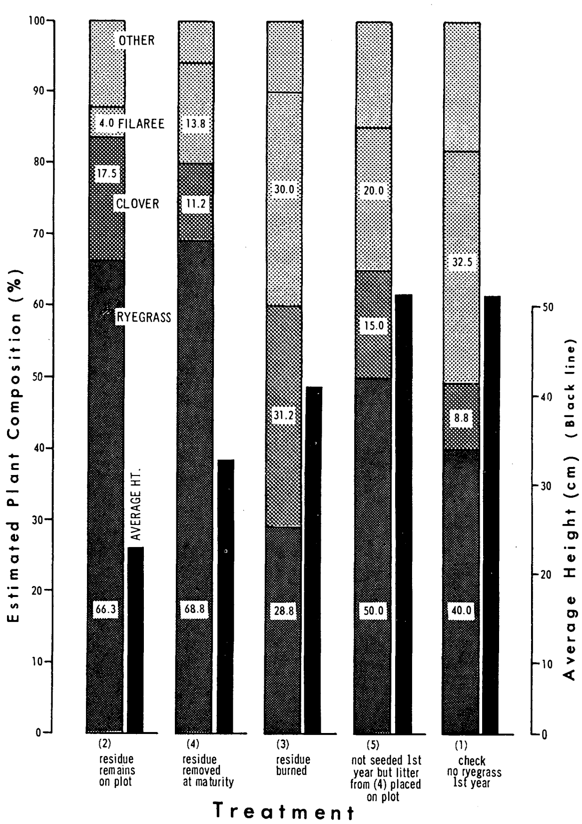

FIG. 5. Species composition and average height of vegetation on plots treated variously to manage the litter from the previous growth of annual ryegrass.

The greatest abundance of annual ryegrass occurred in relation to two treatments, one where the residue from the previous year remained and second on the plots where the residue had been removed after plant maturity. Conversely, filaree occurrence was least on plots of these two treatments.

The height of vegetation on plots receiving the various treatments bore a close relation to the dominance of annual ryegrass (Fig. 5). Vegetation was shortest where annual ryegrass was most abundant. However, where ryegrass was least abundant the vegetation height was close to the medium for all treatments. Vegetation was tallest where no ryegrass had been seeded in the first year of the experiment. Hardinggrass plants were found only on plots that were burned to remove the litter.

Discussion

In each experimental situation annual ryegrass appeared to offer great interference to other species. Even when grown in a monospecific culture at a seed rate equal to the total amount of seed in a bispecific planting, annual ryegrass reduced its own weight per plant significantly both in greenhouse and in field plantings.

It is obvious that in plots seeded with only one species there is more seed of that species than there would be when the total weight of seed consisted of two species. Even so, annual ryegrass appeared to produce plants of about the same weight whether seeded alone or with other species whenever the other species were less aggressive than ryegrass. However, in such combinations some of the associated species did not fare as well as when they were seeded alone. Soil moisture appears to be the critical factor, since only 313 mm of rain fell during the growing season. A period of 42 days without any precipitation intensified drought conditions. The results of the experiments with row and open field planting hold particular significance for rangeland seedings in which annual ryegrass is included. The reduction of the stand of perennial species may well be considerable (McKell et al. 1965) and is a probable cause of lowered production in succeeding years.

Seeding ryegrass in separate rows appears to offer no solution to the problem of interference with other species desired in the stand. The production of associated species can be so reduced as to render them ineffective. Even aggressive weeds such as wild oats may be reduced considerably which could, of course, be worthwhile if any desirable species survived.

The effect of the old litter and plant residues from annual ryegrass on species seeded in the following year is difficult to assess. Does a reduction in establishment and growth of the seeded species reflect the mere mechanical effect of litter and its influence on temperature, light, and soil moisture in the seed bed or is there a particular growth inhibition caused by a substance in the ryegrass litter? This second point will be discussed in succeeding reports. When ryegrass litter is burned, a greater growth of seeded clover can result as compared with other treatments. Even when ryegrass was cut and removed from a plot or when its litter was placed on new plots, an adverse effect was apparent on clover growth. In no case was it possible to eliminate completely the effect of living ryegrass plants since seed scatter from plot to plot was taking place. Here, then, we have the combined influence of litter, living ryegrass, and other species.

Self-interference appeared to be important again in the litter experiments where plant height was least on plots with the most abundant annual ryegrass (treatments 2 and 4). Since these two treatments were quite different from each other in that treatment 4 involved removal of all litter, it cannot be said that the previous year's litter influenced the second year stand of ryegrass.

Clearly, the advantages of annual ryegrass must be weighed against its disadvantages if it is to be included in a seeding of dry rangelands or in other areas where growth of associated species is considered important.

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