



Four-Species Pasture Mixtures Yielded More than Species Grown Alone or in Two-Species Mixtures

Sallee Reynolds and Jennifer MacAdam
Utah State University, Logan, Utah U.S.A.



Introduction

Grazed, irrigated pastures are productive, but nitrates that accumulate under grazing appear to be leached from the root zone by winter and spring precipitation.

Our long-term goal is to make the most effective use of agricultural irrigation water, a costly and increasingly limited resource, while maintaining productivity. The literature suggests that increasing the number of plant species in addition to legumes increases productivity while minimizing nitrogen loss from the system.

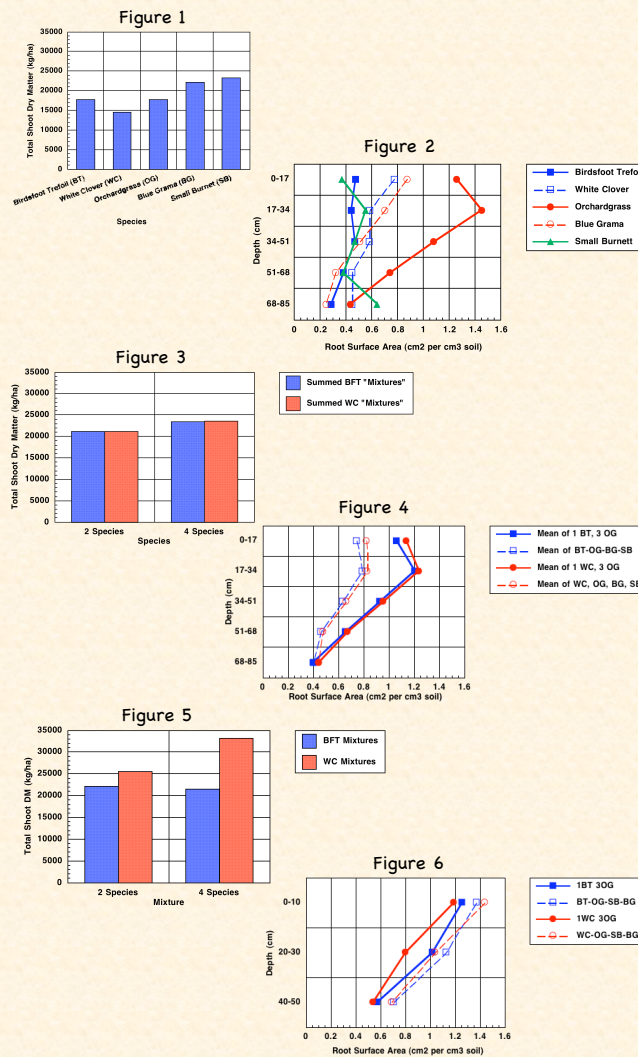
The objective of this study was to determine the effect of increasing the number of plant species in mixtures with legumes on shoot and root development as a first step toward developing mixtures with more effective root zone water and nitrate utilization.

Study Design

Since legumes are the most sustainable source of nitrogen in agricultural systems, we compared two legumes with contrasting root systems: deep-rooted birdsfoot trefoil (*Lotus corniculatus*) and shallow-rooted white clover (*Trifolium repens*). Orchardgrass (*Dactylis glomerata*) was used as the cool-season grass component; blue grama (*Bouteloua gracilis*) as the warm-season grass component, and small burnet (*Sanguisorba minor*) as the non-leguminous forb component.

Studies with species grown separately and as mixtures were carried out in 1-m-deep columns in the research greenhouses at Utah State University. Ten-cm-dia columns were used to grow single plants of a given species, and 20-cm-dia columns were used to grow mixtures of four plants. The volume of soil available to each plant was the same in the two studies. Plants were grown from seed in columns for approximately six months.

After several harvests of shoot DM, plants were destructively harvested to collect roots at intervals within the root zone. Roots were washed and scanned to determine root surface area.



Results

Species differed in shoot DM production: white clover was least productive and small burnet highest (Fig. 1). Root surface area (RSA) of orchardgrass was higher than that of other species in the upper root zone (Fig. 2). Blue grama, while significantly more productive than white clover, did not differ from white clover in RSA, suggesting higher water use efficiency. The RSA of tap-rooted species (birdsfoot trefoil and small burnet) varied little with depth.

If the development of these species were unaffected by interplant competition, the shoot DM of mixtures would be the sum of shoot DM of individual species (Fig. 3) and the RSA (as cm² per cm³ soil volume) of two-species and four-species mixtures would be the mean of individual species (Fig. 4). All mixtures were 25% legume so two-species mixtures contained three orchardgrass plants. The actual shoot DM and RSA of these mixtures is shown in Figs. 5 and 6.

Results from the two studies cannot be compared statistically, but productivity of white clover-orchardgrass was 21% higher than the summed monoculture values, and shoot DM production of the white clover four-species mixture was 40% higher than the summed monoculture values for the same four species. The white clover four-species mixture was also 30% higher in shoot DM than the white clover two-species mixture.

Root surface area of the two-species mixtures was approximately equal to the mean RSA of one legume and three orchardgrass plants grown in monoculture. However, the actual RSA of both four-species mixtures was nearly twice what was predicted from the mean RSA of the four species.

Summary

The higher productivity of the white clover four-species mixture may be due to more efficient exploitation by the forb and warm-season grass of the more rapid nitrogen turnover in white clover than in birdsfoot trefoil. Efficient moisture use and nutrient capture are critical elements of mixtures for irrigated pastures in the Intermountain West. Therefore, the more important result may be the apparent synergy in RSA found in the two four-species mixtures compared with the root production of the same species in monoculture.