Forage Plants in a Montana High Altitude Nursery

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HIGH mountain watersheds are the storehouses for water which is the core of existence in the valleys below. They may also furnish forage to domestic and wild grazing animals. How well they meet these needs depends directly on the type and quality of plant cover. On those watersheds primarily adapted and used for grazing, maintenance or development of a desirable herbaceous cover is especially essential. Where management of grazing alone will not bring about the desired results, reseeding to adapted forage species may be a worthwhile alternative.

The first requirement for effective reseeding is knowing what species will live and thrive in a given environment. This type of information is particularly important for such restrictive environments as are found high in the mountains. From studies made by Forsling and Dayton (1931), Plummer and Fenley (1950), and Doran (1952), evidence has been provided to indicate generally some of the species likely to succeed in high altitude plantings. For other species results have been contradictory. Many more data are needed to show which species are consistently adapted and to describe the ecological limits of those species and strains which show near or occasional adaptation.

This paper compares stand changes, vigor, and some growth characteristics of forty species and varieties in a high altitude nursery in southwestern Montana. Trends of stands over a period of ten years are used for dividing the species tested into groups of varying adaptation.

The Study Area and Methods

This high altitude nursery is located on Lazyman Hill of the Gravelly Range Mountains in the Beaverhead National Forest. Its exposure is to the south-southwest on an 11 percent slope. Elevation is 9,350 feet above mean sea level.

The area is typical of fertile high mountain grasslands in southwestern Montana. Idaho fescue (*Festuca idahoensis*) is the dominant species in the general area, but bearded and slender wheatgrasses (*Agropyron subsecundum* and *A. trachycaulum*), mountain brome (*Bromus carinatus*), bluegrasses (*Poa* spp.), and the forbs—Grandads whiskers (*Sieversia ciliata*), and cinquefoil (*Potentilla* spp.) are important constituents of the community. Big sagebrush (*Artemisia tridentata*) occurs commonly a thousand feet lower in the general region and on some of the south slopes to nearly the same level. Alpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*), and Engelmann spruce (*Picea engelmanni*) are the primary tree species found in nearby timber types at this elevation. High productiveness of the nursery site is indicated by the lush growth of the surrounding native vegetation, which provides basal area cover of 50 percent or more.

Productiveness also is reflected by the soil. The top soil is a chocolate colored, crumb structured, friable clay loam with about 9 percent organic matter content and high water-holding capacity. Reaction is neutral. At 8 inches the soil grades into a light brown color and finally

becomes brick red as the parent material (Quadrant formation of the Carboniferous era) is approached at about 20 inches. The lower layer contains more rocks, has a higher clay content, and is not very permeable to water.

While no weather data are available from the area itself, interpolations from the nearest stations are believed to give reasonably good estimates (United States Weather Bureau, 1926–51). On this basis mean annual temperatures at the nursery probably averaged between 33 and 36 degrees Fahrenheit between 1942 and 1952. April through September temperatures likely ranged between 42 and 47 degrees during this ten-year period, while the other half of the year probably averaged near 19. The January mean was near 10 and that of July and August between 50 and 55 degrees.

There are probably some nights during all months of the year when temperatures fall below freezing, and only between May and September, inclusive, are average monthly temperatures likely to be above freezing. Large diurnal temperature fluctuations, characteristic of the area, are undoubtedly accentuated on the nursery site by the southern exposure.

Annual precipitation at the nursery site is estimated to be at least 20 inches. This is evenly distributed throughout the year, except for a slight peak in June.

The sod on this high altitude nursery site was broken with a walking plow in 1940. In 1941 it was disked and floated. On July 7, 1942, forty forage species were seeded in rod-long rows spaced two feet apart. As far as is known, the seed used was, with one exception, from sources having much lower elevations.

Observations of the seedling stands were made in the fall of 1942. Thereafter, data were collected in late summer or early fall each year from 1942 through 1946 and again in 1950 and 1951. Of the data taken on these plots, those on stand, and to a lesser extent, vigor, were basic in the evaluation of species. Stand was estimated ocularly as the percent of row fully occupied by reseeded plants. Relative vigor estimates were based on apparent robustness and overall size of plants. These estimates were recorded on a scale ranging between one and five, with one representing very poor vigor and five excellent. Observations were also made on stage of development, height growth, reproduction, and certain other characters.

Results

Species Ratings

All species produced fair to excellent seedling stands, but only eight maintained their stands and were vigorous over the entire period, from 1942 through 1951. Others died within three years, while still others responded well for a varying number of years. This variation in time at which stands were affected forms the foundation for the classification used herein.

Those maintaining their stands satisfactorily throughout the period were put in one classification, those failing to do so were grouped according to when the major stand decreases took place and by the intensity of change. When stand changes were plotted five groups which showed the same average responses could be identified. These are shown in Figure 1.

Group I is comprised of those species whose stands were maintained, except for minor fluctuations, or increased during the ten-year period. They are: common and Parkland strains of smooth brome (*Bromus inermis*), meadow foxtail (*Alopecurus pratensis*), meadow brome (*Bromus erectus*), Kentucky bluegrass (*Poa pratensis*), violet, slender, and

bearded wheatgrasses (*Agropyron trachycaulum* var. *violaceum*, *A. trachycaulum*, and *A. subsecundum*). Some of these are shown in Figure 2.

Group II includes those species which responded similarly to those in Group I brome (*Bromus carinatus*) from seed collected near the site.

Group III includes those species that declined sharply between 1946 and 1950 and again between 1950 and 1951. In this group are: intermediate and blue-

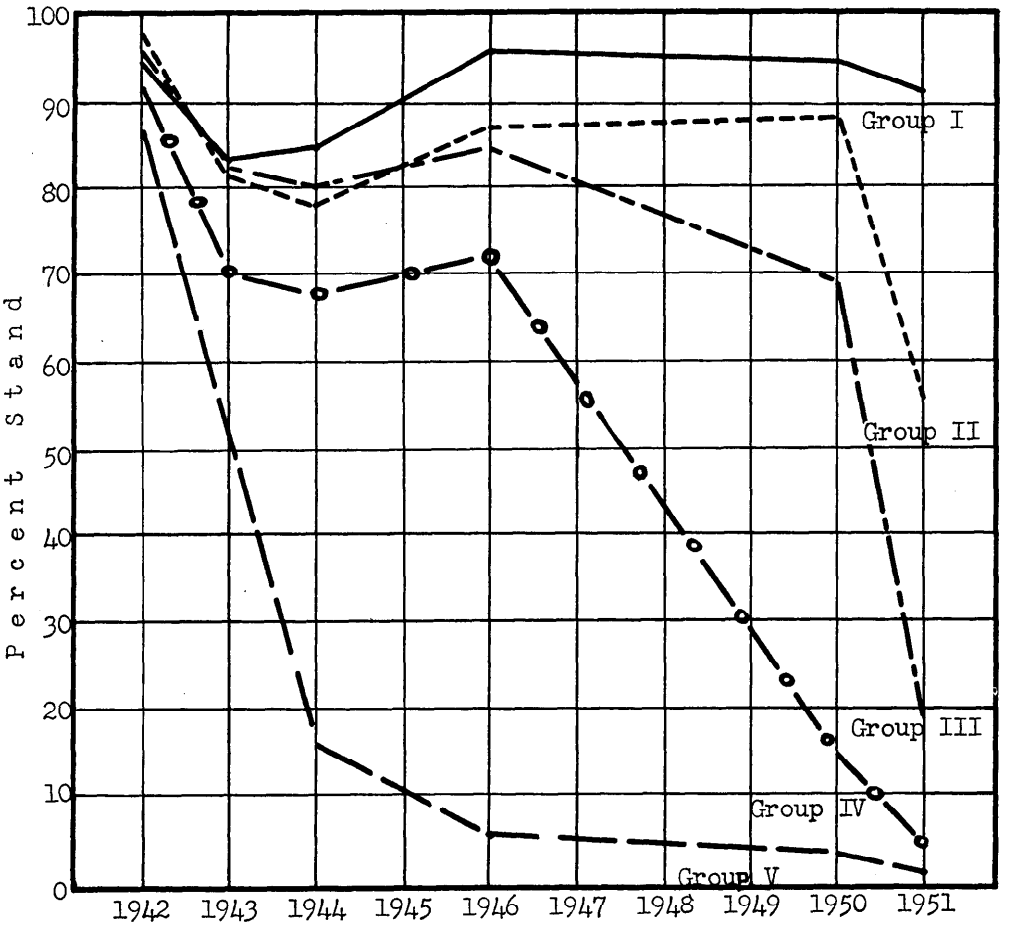

FIGURE 1. Characteristic stand changes of five groups of forage species in a high altitude nursery in southwestern Montana.

until 1951 when an abrupt decline in stand occurred. In this group are: hard fescue (*Festuca ovina duriuscula*), thickspike and Fairway crested wheatgrasses (*Agropyron dasystachyum* and *A. cristatum*), red fescue (*Festuca rubra*), Russian wildrye (*Elymus junceus*), and mountain stem wheatgrasses (*Agropyron intermedium* and *A. smithii*), a perennial barley (*Hordeum brevisubulatum*), and Virginia, Dahurian, and Siberian wildrye grasses (*Elymus virginicus*, *E. dahuricus*, and *E. sibiricus*).

Group IV includes those species which

FIGURE 2. *Upper*—Commercial and Parkland smooth bromes in the dark foreground, and meadow brome to their left, all maintained excellent stands over a 10-year period. The smooth brome varieties spread outside the original plot boundaries. *Lower*—Meadow foxtail, in the immediate foreground, maintained a vigorous stand and was the only species positively known to have reproduced itself by seed. Photographs taken September 16, 1952.

responded similarly to those in Group III, except stands averaged lower, and decreased catastrophically between 1946 and 1950—a decrease which was continued in 1951. This group includes: timothy (*Phleum pratensis*), standard crested wheatgrass (*Agropyron desertorum*), birdsfoot deervetch (*Lotus corniculatus*), and meadow fescue (*Festuca elatior*).

Group V has in it those species which suffered severe kill within the first three years with little or no recovery of any species. Included are: rough and Idaho fescue (*Festuca scabrella, F. idahoensis*), redtop (*Agrostis alba*), bluebunch, Siberian, and beardless wheatgrasses (*Agropyron spicatum, A. sibericum,* and *A. inerme*), tall oatgrass (*Arrhenatherum elatius*), Canada and big bluegrasses (*Poa compressa* and *P. ampla*), a nonnative strain of mountain bromegrass (*Bromus carinatus*), orchard grass (*Dactylis glomerata*), yellow sweetclover (*Melilotus alba*), red, strawberry, and white clovers (*Trifolium pratense, T. fragiferum, T. repens*).

The classification of timothy, tall oatgrass, Idaho fescue, and some others into Group IV or V may appear puzzling inasmuch as seedling stands were good, and mortality between the first and second year not excessive. Lack of establishment does not satisfactorily account for this poor performance. Rather, it may be due to use of unsuitable strains or ecotypes in the source material from lower elevations.

Species Characteristics

Species in Group I are considered well adapted to this site. In 1951 all of them, except bearded and slender wheatgrasses, dominated the plots to the exclusion of all other vegetation. The smooth brome varieties and Kentucky bluegrass had spread uniformly over their plots and were slowly spreading by rhizomes outside the plots. Meadow foxtail had reseeded itself in open spaces to the leeward side of rows of less successful species and in open places just outside the plots. Volunteer slender and bearded wheatgrass plants were found in the nursery, but it was not possible to determine if their seed source was from the seeded or native plants. Violet slender wheatgrass (now considered as an alpine form of slender wheatgrass) was the best of the three wheatgrasses in this group.

Average mature height of leaves in Group I for all years in which measurements were made, ranged from 10.5 inches for Kentucky bluegrass to 16.8 for common smooth brome, two to three inches taller than that for any other group. Vigor ratings of each of these species averaged above 4, on a scale where 5 is considered excellent vigor and 1 very poor. Meadow foxtail, meadow brome, Kentucky bluegrass, and varieties of smooth brome were superior to the other species in terms of stand, vigor, dominance, and ability to spread on this site. The slender wheatgrasses and bearded wheatgrass decreased slightly in both stand and vigor between 1950 and 1951. Maintenance of the slender wheatgrasses over the ten-year period is noteworthy inasmuch as under most conditions they are considered short-lived.

Species in Group II showed fair adaptation. All of them, except hard fescue, had by 1951 been invaded to some extent by various species native to the area—indicating their lack of dominance. Thickspike wheatgrass and red fescue had formed a sod in local spots, but otherwise had spread very little, if at all. No seedlings or volunteer plants of these species were observed. Hard fescue and Fairway crested wheatgrass maintained good stands and robust growth for nine years before apparent winterkill reduced their

stand by about 50 percent. Mountain brome from native seed also maintained its stand until the last year, when it dropped from 90 to 25 percent. No satisfactory explanation was found for the sharp drop in stand of several species between 1950 and 1951. Russian wildrye maintained its stand but lacked robustness.

Average leaf heights ranged from 8.8 inches for Russian wildrye to 12.8 for hard fescue, while average vigor ratings varied from 3.1 for Russian wildrye to 4.3 for hard fescue and red fescue.

Species in Group III failed to maintain dominance of the plots and all were more or less invaded by native grasses and forbs. Remnants of each species, however, were still present in 1951.

Vigor ratings averaged between 2.9 for bluestem wheatgrass and 3.5 for Dahurian wildrye. Average vegetative heights ranged from 6.3 inches for bluestem wheatgrass to 12.2 for Siberian wildrye. The wildrye species were superior to bluestem and intermediate wheatgrasses.

Groups IV and V were comprised of species or strains that were either completely killed or severely reduced in stand at an early date.

Of the species in Group IV, timothy maintained the best stands and had the highest vigor over the entire period. All tall fescue and standard crested wheatgrass plants were dead by 1951. A few tiny plants of birdsfoot deervetch were found the last year. In Group V only Idaho fescue and rough fescue maintained any surviving plants throughout the period of study. None of the clovers was found after the third year. Vigor ratings for most of these species were low, and heights averaged considerably below that of other groups.

The grasses usually remained green and predominately in the vegetative stages of development throughout the summer. Heads were few and for most species did not emerge until August. Even when heads were produced seed formation was rare because heavy frost usually killed the flowers. Species which produced heads four or more of the six years in which observations were made were: meadow foxtail, mountain and meadow brome, Idaho, hard, red, and rough fescues, *Hordeum brevisubulatum* (no common name), and Kentucky bluegrass. Meadow foxtail headed each year. Only meadow foxtail and mountain brome are positively known to have produced viable seed. No heads were produced on intermediate wheatgrass, only twice on Fairway crested wheatgrass, and three out of the six years on standard crested wheatgrass. None of the legumes bloomed. Survival did not appear to be associated with whether or not the plant tended to produce flower stalks.

Discussion and Recommendations

The best criterion for selecting an adapted species for reseeding is consistently high performance under a given set of conditions. Despite the relative scarcity of data on species reseeded at high altitudes, enough are available to give a start in evaluating some of them. Forsling and Dayton (1931) recommended smooth brome, Kentucky bluegrass, violet slender wheatgrass, native mountain brome, native thickspike wheatgrass, and Canada bluegrass (for dry sites) and redtop (for moist sites), for high altitudes where annual precipitation was 30 or more inches. Plummer and Fenley (1950) concluded from their studies in Utah that smooth brome, meadow brome, meadow foxtail, slender wheatgrass, Kentucky bluegrass, mountain brome, tall oatgrass, orchardgrass, and timothy were adapted to high eleva-

tions where local conditions were not limiting.

Doran (1952) reported that in high mountain parks in Colorado ratings of intermediate wheatgrass, several smooth brome varieties, meadow and tall fescues, timothy, meadow foxtail, Kentucky bluegrass, redtop, and sheep fescue all averaged good or excellent over a three- to five-year period. He reported poor ratings for common tall oatgrass but a rating of good for the Tualatin strain of this species. Meadow brome was given a poor to fair rating and mountain brome fair. Standard and Fairway crested wheatgrass were rated as good on a 9,200 foot site but as failures on a 10,300 foot site.

Favorable response of tall fescue, orchardgrass, timothy, red top, sheep fescue, and Canada bluegrass cited from the above studies are in contrast to the results found in Montana and reported in this paper. The poorer response of these species in Montana may have been due to a number of factors. Prominent among these is the higher latitude, corresponding with a shorter growing season and conversely a longer winter. In addition, variations in strains and in site may have been important. Length of study also could have been highly influential. Doran, for example, reported on 3- to 5-year-old plantings. Many of the species planted in the Montana nursery, however, performed well until the tenth year, when abrupt drops in stand occurred.

Based on the results from this study and the others mentioned, the most reliable species for reseeding Montana high mountain ranges are smooth brome (northern strains are probably the best choice), meadow brome, meadow foxtail, and Kentucky bluegrass.

While needing further testing to delineate their limitations, and in some cases to establish which are suitable strains, slender wheatgrass (especially the alpine form), bearded wheatgrass, and native mountain brome are probably good alternatives. Native mountain brome may be particularly useful for securing quick but somewhat shorter lived stands and in mixtures. Hard fescue, tall oatgrass, orchardgrass, and timothy, whose performance was unsatisfactory in the Montana nursery, might do very well at a somewhat lower elevation if site conditions were not otherwise limiting.

That survival of certain species in the highly selective environment of high mountains may be a function of strain or ecotype is suggested not only by the contradictory results from different regions, but also by certain observations made in this study. In this study, the alpine form of slender wheatgrass (violet) was superior to the common strain. Fairway responded markedly better than standard crested wheatgrass. Native mountain brome maintained a good stand much longer than the common strain. Although Idaho fescue is dominant around the nursery, the seed from the same species growing near Missoula at about 3,500 feet produced plants of little survival capacity; and although rough fescue and big bluegrass also occur at rather high elevations, reseeded stands from low altitude seed sources were mostly killed the first winter.

These results emphasize the need for knowing: (1) whether the range of ecological adaptability of a species is such that it will grow in a variety of environments including high altitudes; and (2) whether the particular strain being used is adapted to high elevations. Both of these needs call for a great deal of research before reseeding at high elevations can be expanded to meet existing needs.

Summary

Forty forage species were planted in nursery plots at 9,350 feet in southwestern Montana in 1942. Annual rain-

fall at the site approximates 20 inches; summer temperatures are low, and soil is fertile.

Primarily on the basis of stand changes, species are classified into five groups of adaptation. All species in Group I maintained high stand and vigor levels throughout the 10-year test period. Most of them dominated the plots to the exclusion of other vegetation. Group II includes those species which maintained their stands well until the last year. For the most part, they lacked dominance and were generally invaded by various native species. Groups III and IV began to decline in stand in 1946, but the decline of Group IV was most severe. Group V includes those species which declined to almost complete extinction within the first two or three years.

Species included in Group I are: common and Parkland smooth brome, meadow brome, meadow foxtail, Kentucky bluegrass, violet and common slender wheatgrasses, and bearded wheatgrass. Northern strains of smooth brome are probably generally adapted to high elevations. Of the species and varieties listed above the first five are recommended as being most reliable for reseeding Montana subalpine areas similar to the kind described in this paper.

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