Yield and Crude Protein Concentration in Forage Species and Cultivars Adapted to Oregon Improved Meadowlands

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YIELD AND CRUDE PROTEIN CONCENTRATION IN FORAGE SPECIES AND CULTIVARS ADAPTED TO OREGON IMPROVED MEADOWLANDS

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INTRODUCTION

Forage and livestock production is essential to the economy of southeastern Oregon and other range and meadowlands of the Intermountain Region. Because of the climate and weather extremes, only frost-hardy species and cultivars can endure the harsh environment of these areas. Native grasses and legumes have adapted to their environment but the average production of native meadows is only 3/4 ton/acre. In recent years, many new strains and species of forage have been introduced to agriculture, but little has been published concerning their potential use on the improved meadowlands of southeastern Oregon.

Beginning in 1969, a series of experimental plantings for evaluating forage grasses and legumes were made. Information on the yield and quality of these forages can relate to increased livestock production.

GENERAL SITE CONDITIONS

Yield and quality studies of grasses and legumes were conducted at the winter headquarters (Section 5) of the Squaw Butte Agricultural Experiment Station, about six miles southeast of Burns, Oregon, at an altitude of 4,135 feet. Research at the Squaw Butte Station was done cooperatively by the Oregon Agricultural Experiment Station, Oregon State University, and the U.S. Department of Agriculture acting through the Science and Education Administration, Agricultural Research (formerly Agricultural Research Service).

Soil and Native Plant Characteristics

The soil, tentatively classified as Silvies series-Fluventic and Cumulic Haplaquolls, is predominantly silt loam in texture and basic in reaction with pH of 7.5 to 8.0. It was developed from lacustrine sediments and alluvium deposits from the Silvies River. In its natural state, the site was a wetland meadow subjected to seasonal flooding and a high water table. Production of native plants varied depending on depth of flooding and the length of the flooding period. Primary species were slender sedge (*Carex praegracilis* W. Boott), Nevada bluegrass (*Poa nevadensis* Vasey ex Scribn.), beardless wildrye (*Elymus triticoides* Buckl.), and Baltic rush (*Juncus balticus* Willd.). A variety of grasses and forbs were present in the associated meadow. The study site was part of a water control project, with the water table lowered and maintained at a depth of 2 1/2 to 4 feet when the surrounding meadowland was flooded. After the flooding period, the water table receded until it stabilized at a depth of about 15 feet.

The climate prevailing near Burns, Oregon, is representative of the high desert country of southeastern Oregon. Annual rainfall averages about 12 inches, but the primary source of irrigation water is from flood water and pumped ground water. Average annual temperature at Burns is about 46°F with an average daily maximum in July of 86°F and an average daily minimum in

January of 16°F (Johnsgard, 1963). Comparisons of temperature data suggest, however, that the growing season at the Experiment Station is considerably shorter than recorded at the official National Weather Service. Average frost-free period is about 83 days, varying from 20 to 116 days (Gomm, 1979a).

EXPERIMENTAL PROCEDURES

Meadow sod was broken by plowing during the fall of 1967 and planted to barley in the spring of 1968. After the barley crop was harvested, the seedbed was again worked for planting to forage nurseries or to alfalfa. In the spring of 1969, three nurseries were planted: 19 alfalfa cultivars, 16 species-cultivar selections of miscellaneous legumes, and 14 species-cultivar selections of grasses. Common names, species, and cultivars are listed in Table 1. Plots were arranged in randomized block designs with four replications. Each plot was 6 X 40 feet.

In 1973, the miscellaneous legume study was plowed out because of generally poor stands and replanted. Failed grass plots also were rototilled and replanted to orginal selections.

In 1973, nursery plantings were made of 22 alfalfa cultivars; 19 species-cultivars of miscellaneous legumes, and 18 species-cultivars of grasses. Seeding was through flexiplanter drills to plant approximately 25 live seeds/linear foot of row. Rows were spaced 6 inches apart in 6-X 25-foot plots, and plots were each replicated three times.

In the fall of 1975, an area planted in 1969 to alfalfa was plowed. In the spring of 1976, it was planted with 22 alfalfa cultivars, 6 bromegrass cultivars, 9 orchardgrass cultivars, 3 tall fescue cultivars, 2 reed canarygrass cultivars, and 4 timothy cultivars. Additionally, grass-alfalfa mixture plots were planted to Promor alfalfa with each of the following grasses: Manchar smooth brome, Regar meadow brome, Latar orchardgrass, and Fawn tall fescue. Nursery plantings were made using the 1973 planting procedures.

From 1973 to 1977, all grass plots were fertilized with nitrogen at 60 pounds N/acre in late May and again in mid-July.

Two to three cuttings of alfalfa were made annually. The number of cuttings depended on plant development in the spring as influenced by

temperature and weather. Only one cutting of grasses was made annually 1970 to 1972; three cuttings were made annually in 1973 and 1974, and two cuttings were made annually 1975 to 1977.

Pasture mixtures--Vernal alfalfa with Fawn tall fescue and white clover with Fawn tall fescue--were planted in 1969. In 1976, Latar orchardgrass was planted with Promor alfalfa. Samples of grass and legume components were taken periodically at the beginning of grazing periods. Management of cattle and pastures were previously reported (Gomm, 1979b).

Forage samples were dried, ground, and chemically analyzed for crude protein using the standard Kjeldahl method. Reed canarygrass was periodically harvested in 1973 to determine crude protein and nitrate concentrations. Nitrate-N was determined using the method of Bremner and Edwards (1965) as modified for plants by the Soils Testing Laboratory of Oregon State University.

RESULTS AND DISCUSSION

Grass Nurseries

1969 planting: Of the 14 species and selections planted, only six established fair to good stands (Table 2). Initially, Sawki Russian wildrye established poorly, but stands improved and productions generally increased until it was producing yields similar to the other species. The reason eight of the species failed or established poor initial stands is not known. All of these, except Sawki Russian wildrye, were replanted in 1973. Of the replanted species, all except Primar beardless wheatgrass established good stands and continued to produce good yields through the next four years.

When only one cutting was made (early in mid June, 1970 to 1972), Oahe intermediate wheatgrass consistently outyielded the other species (Table 2). When two or three cuttings were harvested, total yields of most species were similar, except for Primar beardless wheatgrass and Vinall Russian wildrye, which consistently produced less than the other species. Although most of the grasses yielded higher in the first cutting, orchardgrass and tall fescue produced more in later cuttings. The wheatgrasses and smooth bromegrass were slow to generate new growth. Species which recovered most quickly were meadow brome, meadow foxtail, and orchardgrass.

Yields generally were highest in 1974 even for the replanted species. The high yields in 1974 were attributed to good growing conditions and three-cutting harvests. In succeeding years, although yields varied by species, production was similar among years.

Chemical analysis of second-cutting herbage, harvested in mid-July 1973, showed little difference in crude protein concentration among the grasses. But the crude protein concentrations of herbage in 1973 were lower than those in

herbage harvest in 1974 (Table 3). The difference in crude protein concentrations for the two years must be related to unknown year-difference factors since the growing intervals between cutting dates were similar. Generally, crude protein concentrations in herbage harvested in August 1974 were higher than those in herbage harvested in July the same year. The regrowth in both the second and third cuttings were relatively high in crude protein (9.3 to 17.2%) indicating that good forage quality can be maintained late into the summer by harvesting several times during the growing season.

1973 planting: Good to excellent stands of all species, except blue grass and western wheatgrass, established in the seedling year (Table 4). The following year (1974), stands of all species had improved. Yields among species were variable. Highest producing species were tall fescue, orchardgrass, and smooth brome. Timothy and meadow foxtail also yielded well in 1975, but yields declined in 1976 and 1977. Although the bluegrass and western wheatgrass established poor stands initially, production increased as their stands improved.

Crude protein concentrations in the herbage were good (9.8 to 16.4%) in the June 22 cutting and, generally, concentrations were higher in the regrowth herbage cut August 10 (12.6 to 19.3%) than they were in the earlier cutting (Table 5). Species that contained highest levels of crude protein through the season were the bromegrasses, reed canarygrass, timothy, and bluegrass. Wheatgrass, orchardgrass, and meadow foxtail species contained intermediate levels of crude protein; the tall fescue cultivars consistently were the lowest.

1976 planting: Good stands of all cultivars were established. In the second year (1977) two cuttings were made, June 27 and August 10. Yields averaged about 3 T/A. Generally, variations in yield were greater within species than among species (Table 6). Tall fescue was the highest producing species with Clarine producing 6.4 T/A and Fawn yielding 5.3 T/A. Blair

appeared to be the highest producing bromegrass, yielding 3.4 T/A. Four cultivars of orchardgrass yielded more than 3 T/A. They were OX-1, 4.0 T/A; Dayton, 3.7 T/A; Comet, 3/4 T/A, and Orbit 3.0 T/A. Also, Climax timothy yielded 4.2 T/A, Regar brome 3.1 T/A, and Lincoln brome 3.0 T/A.

Crude protein concentrations in the regrowth-herbage harvested August 10 were high (11.1 to 26.7%, averaging 16.7%). Variations in crude protein concentrations were as great among cultivars as among species, except that the reed canarygrass cultivars contained the highest levels (Rise, 26.7%, and Vantage, 23.5%). These concentrations in reed canarygrass were considerably higher than the crude protein concentrations determined in herbage of a common selection tested in another study (Table 7).

Analyses of reed canarygrass herbage at different stages of growth (Table 7) showed crude protein concentrations of 4.9 to 17.4 percent. The highest concentration was in regrowth sampled 40 days after cutting. Although regrowth was not tested at shorter periods of growth, the crude protein concentration in less mature regrowth probably would have been higher. Because the regrowth harvested August 10, 1977 (Table 6) was from a growing period similar to that of the regrowth harvested July 17, 1973 (Table 7), the differences in crude protein concentrations were attributed to year, season, or cultivar differences.

Under stressed growing conditions, reed canarygrass can accumulate nitrate levels dangerous to livestock. Although herbage samples contained significant amounts of NO_3-N early in the growth period (Table 7), nitrate concentrations were not high enough to be toxic. The NO_3-N level considered to be lethal to cattle is 0.21 percent.

Alfalfa Nurseries

1969 planting: Although initial establishment of all cultivars was good, yields in 1970 and 1971 were low (Table 8), and the poor response was attributed to faulty irrigation. Yields in 1972 to 1976 were good, but production of most cultivars was below average in 1977. Moapa-69 was consistently the lowest producing cultivar. The low yields were attributed to winterkilling after the first season. This cultivar is a nonhardy selection not suited to severe winter conditions. Promor, Resistador, Cayuga, Culver, Uinta, WL303, Narragansett, Grimm, and Ranger consistently were high producers.

Crude protein concentrations in herbage harvest at two cuttings (July 14 and August 24) were high (16.2 to 27.4%, Table 9). Cultivars varied more in crude protein concentrations from the July 14 cutting than they did from the August 24 cutting. Cultivars low in crude protein were AS-49 and Lahontan. In later tests, however, the crude protein concentration in Lahontan was similar to that for other cultivars.

Nomad, Rambler, and Teton were the slowest to recover after cutting, and Moapa-69 and Lahontan were the quickest to regrow (Table 10). These two cultivars and Resistador grew to more than 24 inches tall in 38 days after cutting. During the same growth period, Nomad grew to 12.5 inches, Rambler, 12.5 inches, Teton, 14.5 inches, and Ladak, 15.0 inches. Although low growing, Teton and Ladak yielded similar to most of the taller growing cultivars.

1973 planting: Excellent stands of all cultivars were established in the seedling year (Table 11). Moapa-69 winterkilled in 1973-1974 as did 919 Brand in 1974-1975. The 919 Brand, a blend, appeared to contain a nonhardy variety. Stands of the other cultivars improved as crown growth developed. In 1974, nine cultivars yielded more than 5.5 T/A. That number was reduced in 1975 to four, and in 1976 to two cultivars (Polar I and Action). The average 4-year

production for all cultivars was 4.69 T/A with Action, Apalachee, Polar I, Beltsville-72, Thor, Valor, and Promor the highest producing cultivars. Only two cultivars averaged less than 4.0 T/A. These were Moapa-69 and 919 Brand.

In 1974, crude protein concentrations were determined May 15 and June 6 from previously uncut herbage. Additional cuttings of regrowth herbage were made July 12 and August 23. As expected, the crude protein concentrations in the May 15 samples were consistently higher than they were June 6 (Table 12). This was because plants were less mature at the earlier date. Differences among varieties and harvest dates varied only slightly averaging 18.6 percent crude protein. The plants in the June, July, and August cuttings were at a bud-prebloom stage of development.

1976 planting: All cultivars established excellent stands. In the first year after establishment (1977), all but four yielded more than 4.5 T/A (Table 13). The low producing cultivars (Action, Culver, Resistador, and Promor), however, were among the highest long-term producers (Tables 8 and 11). These cultivars, therefore, should not be discounted because of low performance in their first year of production. It is expected that in subsequent years they would yield equal to or exceed other varieties.

Miscellaneous Legumes

1969 planting: Initially, 12 of the 16 selections established fair to good stands; however, by 1973, sainfoin was the only species which warranted observation. Subsequently, the study was plowed out and replanted.

1973 planting: Good to excellent stands of most selections were established (Table 14). Establishment of cicer milkvetch, however, was only fair and crown vetch was poor. By 1974, *Medicago littoralis* and the

strawberry clovers had failed, and stands of Vega birdsfoot trefoil and crown vetch were poor. The highest production of most selections was in 1974. Yields declined in 1975, 1976, and 1977.

Red clover yielded higher than the other miscellaneous legumes and production of the birdsfoot trefoils, sainfoin, and milkvetch was similar. New Zealand selection of white clover also produced fair yields. Comparison of these legumes with alfalfa (Table 11) suggests that adapted cultivars of alfalfa outyielded all other legumes and that alfalfa maintained higher production levels during subsequent years.

Grass and Alfalfa for Hay

Alfalfa (Promor) yielded more drymatter in two cuttings than did grasses planted alone (Table 15). However, simple grass-alfalfa mixtures with smooth brome, orchardgrass, and meadow brome yielded similarly to the pure stand of alfalfa. In this study, the grass component was only 10 to 25 percent of the total herbage, but in subsequent years, as the grasses became better established, it is suspected that the percentage of grass would increase. The alfalfa component yielded more from the first cutting than it did the second cutting while the grasses, except smooth brome, produced as much or more in the second cutting as they did in the first. Typically, smooth brome recovers slowly after cutting and the regrowth herbage of hay mixtures is mostly alfalfa. Orchardgrass, tall fescue, and meadow brome recover well after cutting and contribute significantly to the total yield of regrowth.

The crude protein concentration of the alfalfa component, when cut about 1/3-bloom, averaged 15.2 percent in the first cutting and 17.4 percent in the second cutting (Table 16). The crude protein concentration of the grasses varied among species both in straight seedings and in mixtures with alfalfa.

Although differences in crude protein concentrations in grasses from mixtures and grasses from straight seedings were not significant, the average concentration of grasses in mixtures was 0.5 percent higher in the first cutting and 1.3 percent higher in the second cutting than the average concentration of grasses from straight grass seedings. This indicated that alfalfa may have contribute nitrogen to the grasses grown in the mixtures. Tall fescue consistently contained lower concentrations of crude protein than the other grasses. Therefore, when producing hay it may be more desirable to grow orchardgrass or brome with alfalfa than tall fescue with alfalfa.

Grasses and Legumes for Pastures

Yearling herefords gained more per head per day from orchardgrass-alfalfa pasture than they did from tall fescue-alfalfa (Table 17). When pastures were stocked at 3 head/acre, the steers gained 1.9 lb/head/day (144 pounds) in 76 days on the orchardgrass pastures.

Yearling heifers grazing tall fescue-alfalfa pastures gained 0.1 lb/head/day more than a similar group on tall fescue-clover pastures (Table 17). In a 112-day grazing season, the yearlings gained 221 pounds from pasture mixtures containing alfalfa. The difference in gain, attributed to the legume component, depended on the proportion of legume in the herbage. Pastures containing high percentages of clover were about equal in beef production to those pastures containing similar amounts of alfalfa (Gomm, 1979b).

Calves born in October and weaned onto pasture the following spring gained 0.37 lb/head/day more on orchardgrass-clover pasture than they did on tall fescue-clover (Table 18). When pastures were stocked at 6 calves/acre, they averaged 147 pounds gain in 76 days (May 17 to August 1) on the orchardgrass pastures. From August 1 to October 4, the calves continued to gain 0.55 lb/head/day more from the orchardgrass-legume pastures than they did from the tall

fescue-legume pastures. Calves weaned in late July from cows on range lost weight on the tall fescue pastures during the first 30 days after weaning, but their gains were similar to those of the early weaned calves during the later part of the grazing season.

SUMMARY AND CONCLUSION

Beginning in 1969, a series of adaptation nurseries of grasses, alfalfa, and miscellaneous legumes were planted at Squaw Butte winter headquarters (Section 5) near Burns, Oregon. The studies were established on well prepared seedbeds and maintained under water controlled and irrigated conditions.

Of the 46 cultivars of alfalfa tested, only two failed because of winter killing. They were Moapa-69, a non-hardy variety, and 919 Brand, a commercial blend. Most cultivars established good to excellent stands and yielded 4 to 5 tons/acre, especially in 1974, the peak production year of both the 1969 and 1973 plantings. Highest yielding varieties were Promor, Resistador, Cayuga, Culver, Uinta, WL303, Narragansett, Ranger, Grimm, Vernal, Polar I, Thor, Action, Valor, Apalachee, and Beltsville-72.

Differences in crude protein concentrations were significant among alfalfa cultivars and between cutting dates. Differences in crude protein levels were related to plant maturity and year influences. None of the cultivars, however, contain low levels of crude protein in all tests.

Although most of the miscellaneous legumes initially established good stands from the 1969 planting, most selections, except sainfoin, died out. In the 1973 planting, crown vetch, strawberry clover, and *Medicago littoralis* died out after the first growing season. The red clovers, birdsfoot trefoils, and Onar sainfoin produced good yields in 1974 but production declined considerably during the next two years. It was concluded that alfalfa, where adapted, should yield more hay and maintain higher production over a longer period of time than any of the miscellaneous legumes considered. Livestock gains, however, may be as high on clover-grass pastures as on alfalfa-grass depending on the legume content of the forage.

Of the 19 species of grasses tested, smooth brome, orchardgrass, tall fescue, and meadow brome were the highest producers when more than one cutting

was made during the growing season. Oahe intermediate wheatgrass was a high producer at the first cutting, but as with other wheatgrasses, regrowth was slow and second cutting yields were poor.

Differences in yields were as great among grass cultivars within a species as they were among species. Those which produced well under irrigated conditions were bromegrass (Blair, Manchar, Lincoln, Baylor, and Regar), orchardgrass (Dayton, OX-1, Comet, Nordstern, and Orbit), tall fescue (Clarine, Fawn, and Alta), Vantage reed canarygrass, and Climax timothy.

Crude protein concentrations in the herbage were similar for most grasses at any date of cutting; however, the tall fescues were generally lower than most of the other species. In 1977, reed canarygrass contained the highest crude protein level of any other grass. This, however, was not consistent with samples of reed canarygrass taken at various growth stages in 1973.

Alfalfa-grass mixtures produced about the same or more dry matter as alfalfa alone and more than any of the grasses grown alone. Regrowth of smooth brome was slow and contributed little to the second cutting of hay. Orchardgrass, tall fescue, and meadow brome, however, produced considerable regrowth and were significant components of second cutting hay.

Differences in crude protein concentration in the grass components of mixed hay were small; however, tall fescue was consistently lowest. Although differences among grass samples taken at a specific date were not significant, grasses grown with alfalfa averaged 0.5 to 1.3 percent higher in crude protein than grass grown alone.

Pasture forage should contain a legume. Yearling herefords grazing alfalfa-tall fescue pastures averaged 0.1 lb/day more gain than similar groups grazing clover-tall fescue pastures. The differences in gain between pastures, however, was related to the proportion of legume in the forage.

Yearling and weaned calves gained better from pastures containing orchardgrass than those containing tall fescue.

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Table 1. Names of forage species and cultivars mentioned.

Common name	Scientific Name	Cultivar
Desert wheatgrass (crested)	*Agropyron desertorum* (Fisch.) Schult	Nordan
Intermediate wheatgrass	*Agropyron intermedium* (Host) Beauv.	Greenar, Oahe
Tall wheatgrass	*Agropyron elongatum* (Host) Beauv.	Alkar, Jose
Streambank wheatgrass	*Agropyron riparium* Scribn. & Sm.	Sodar
Western wheatgrass	*Agropyron smithii* Rydb.	P-727
Slender wheatgrass	*Agropyron trachycaulum* (Link) Malte	Primar
Pubescent wheatgrass	*Agropyron trichophorum* (Link) Richt.	Luna
Creeping foxtail	*Alopecurus arundinaceus*	Garrison
Meadow foxtail	*Alopecurus pratensis* L.	P-5903
Meadow brome	*Bromus biebersteinii* Roem.and Schult.	Regar
Smooth brome	*Bromus inermis* Leyss.	Baylor, Blair, Lincoln, Manchar
Pumpelly brome	*Bromus pumpellianus* Scribn.	Polar
Orchardgrass	*Dactylis glomerata* L.	Akaroa, Comet, Dayton, K8-119, Latar, Napier, Nordstern, Orbit, OX-1, Pomar
Russian wildrye	*Elymus junceus* Fisch.	Sawki, Vinall
Tall fescue	*Festuca arundincaea* Schreb.	Alta, Clarine, Fawn
Reed canarygrass	*Phalaris arundinacea* L.	Rise, Vantage
Timothy	*Phleum pratense* L.	Climax, Itasca, Timfor, Toro
Big bluegrass	*Poa ampla* Merr.	Sherman

Table 1. Cont'd.

Common name	Scientific name	Cultivar
Kentucky bluegrass	*Poa pratensis* L.	Cougar
	Legumes	
Chickpea milkvetch	*Astragalus cicer* L.	Cicar
Crownvetch coronilla	*Coronilla varia* L.	Chemung
Birdsfoot trefoil	*Lotus corniculatus* L.	Cascade, Empire, Granger, Mansfield, Vega
Sainfoin	*Onobrychis viciifolia* Seop.	Eski, Onar
Alfalfa	*Medicago sativa* L.	Action, Agate, Apalachee, AS-49, AS-63, Apollo, Atlas, Beltsville-72, Cayuga, Culver, DuPuits, Gladiator, Grimm, Haydak, Haymaker, Iroquois, K4-120, Ladak, Lahontan, Lancer, Marathon, Moapa-69, Narragansett, Nomad, N7-5, Olympic, Orenburg, Pacer, Polar-1, Promor, Rambler, Ranger, Resistador, Saranac, Spredor, Team, Teton, Thor, Uinta, Valor, Vernal, Victor, Washoe, WL-303, 622, and 919
-	*Medicago littoralis* Rohde ex Loisel.	
Strawberry clover	*Trifolium fragiferum* L.	Palestine, Salina
White clover	*Trifolium repens* L.	Ladino KO-176, New Zealand
Alsike clover	*Trifolium hybridum* L.	Aurora
Red clover	*Trifolium pratense* L.	Altasweet, Kenland, K9-119, Ulva

Table 2. Yield of grasses planted in 1969.

Species	Cultivar	Hay yield tons/acre 1970 1/	1971 1/	1972 1/	1973 2/	1974 2/	1975 3/	1976 3/	1977 3/
Agropyron desertorum	Nordan	2.03	1.43	0.86	2.57	2.26	2.59	1.43	2.15
A. intermedium	Greenar	2.28	1.63	0.91	2.71	3.28	2.03	2.05	2.34
	Oahe	3.69	2.89	1.15	2.77	4.21	2.68	1.99	2.41
A. trachycaulum	Primar 4/	-	-	-	-	1.82	1.98	0.77	1.85
Alopecurus arundinaceus	Garrison 4/	-	-	-	-	4.18	3.03	1.85	2.26
A. pratensis	P-5903	0.58	1.06	0.67	2.46	3.78	2.56	1.86	2.28
Bromus biebersteinii	Regar	1.52	1.47	0.76	3.23	3.37	2.98	2.63	2.44
B. inermis	Manchar	0.67	1.57	1.08	2.67	3.46	2.53	2.05	2.70
Dactylis glomerata	Akaroa 4/	-	-	-	-	3.64	2.53	2.41	2.47
	Latar 4/	-	-	-	-	3.94	3.68	2.19	3.14
Elymus junceus	Sawki	0.02	1.19	0.83	3.27	3.19	2.90	1.93	2.69
	Vinall 4/	-	-	-	-	2.57	2.53	0.73	1.65
Festuca arundinacea	Alta 4/	-	-	-	-	4.11	3.69	2.67	3.07
	Fawn 4/	-	-	-	-	4.36	2.91	2.28	2.89

1/ Single harvests were made in June; regrowth was not determined.

2/ Three cuttings were made.

3/ Two cuttings were made.

4/ Replanted in 1973.

Table 3. Crude protein concentration in grass herbage at different harvests.

Species	Cultivar	Percent crude protein[1/] July 19, 1973	July 12, 1974	August 26, 1974
Agropyron desertorum	Nordan	8.5	15.7 de	15.4 de
A. intermedium	Greenar	9.0	13.9 cd	15.7 de
	Oahe	9.7	16.4 e	16.3 de
Alopecurus arundinaceus	Garrison	-	9.7 ab	13.4 bc
A. pratensis	P-5903	8.0	11.8 bc	14.1 a
Bromus biebersteinii	Regar	7.4	11.4 ab	11.2 a
B. inermis	Manchar	10.6	14.4 de	17.2 e
Dactylis glomerata	Akaroa	-	10.9 ab	13.9 cd
	Latar	-	9.3 a	12.3 abc
Elymus junceus	Sawki	9.8	15.2 de	16.7 e
Festuca arundinacea	Alta	-	10.1 ab	11.9 ab
	Fawn	-	10.9 ab	12.5 abc

[1/] Values within dates followed by the same letter are not statistically different at $P<0.05$.

Table 4. Stand establishment and herbage yield of grasses planted in 1973.

Species	Cultivar	Percent stand		Hay yield tons/acre				Avg.[1/]
		1973	1974	1974	1975	1976	1977	
Agropyron desertorum	Nordan	75	95	1.15	0.64	1.12	1.05	0.99c
A. elongatum	Alkar	72	82	2.12	1.42	1.02	1.33	1.47cd
	Jose	70	80	1.06	1.08	0.76	1.20	1.02c
A. intermedium	Oahe	75	82	3.11	1.14	1.39	1.99	1.91de
A. riparium	Sodar	70	72	1.20	0.56	1.30	1.05	1.02c
A. smithii	P-727	40	45	0.01	0.23	0.10	0.46	.20ab
A. trichophorum	Luna	77	85	2.45	1.42	1.02	1.42	1.58cd
Alopecurus pratensis	P-5903	68	78	2.17	3.15	1.64	1.86	2.20de
Bromus inermis	Lincoln	82	92	3.85	2.55	.207	2.35	2.70fg
B. pumpellianus	Polar	65	82	2.43	3.38	1.85	2.05	2.43e
Dactylis glomerata	Nordstern	88	95	3.39	4.07	2.27	3.41	3.28fg
Festuca arundinacea	Alta	92	95	4.41	3.27	2.76	3.56	3.50g
	Fawn	85	87	3.75	3.46	2.38	3.78	3.34g
Phalaris arundinacea	-	85	90	2.65	2.67	1.50	2.23	2.26de
Phleum pratense	Climax	85	88	3.09	2.89	2.28	1.77	2.50ef
	Timfor	90	92	2.70	2.37	1.45	1.18	1.92de
Poa ampla	Sherman	33	55	0.02	0.03	0.12	0.49	0.16a
P. pratensis	Cougar	38	80	0.03	0.73	1.22	1.59	0.89bc

1/ Mean values followed by the same letter are not statistically different at $P<0.05$.

Table 5. Crude protein concentration in herbage of grass harvested at two cutting dates, 1977.

Species	Cultivar	Percent Crude Protein 1/ June 22	August 10
Agropyron desertorum	Nordan	12.4 cde	14.5cdef
A. elongatum	Alkar	12.1 cde	12.6a
	Jose	14.2 fg	13.2abc
A. intermedium	Oahe	11.1 bc	15.5efg
A. riparium	Sodar	12.6 de	13.2abc
A. smithii	P-727	14.2 gh	13.8abcd
A. trichophorum	Luna	13.2 ef	13.5abcd
Alopecurus arundinaceus	P-5903	13.8 f	13.8abcd
Bromus inermis	Lincoln	13.2cde	15.8fg
P. pumpellianus	Polar	13.1ef	19.3j
Dactylis glomerata	Nordstern	12.0cd	14.7defg
Festuca arundinacea	Alta	9.8 a	12.7a
	Fawn	10.6ab	13.0ab
Phalaris arundinacea	-	16.4h	17.4hi
Phleum pratense	Climax	12.6de	16.0gh
	Timfor	12.3cde	17.5i
Poa ampla	Sherman	15.8h	14.2bcde
Poa pratensis	Cougar	13.4ef	14.6defg

1/ Values within dates followed by the same letter are not significantly different at $P<0.05$.

Table 6. Herbage yield and crude protein concentration of grass in 1976 planting, 1977[1/].

Species	Cultivar	Herbage yield[2/] tons/acre	Percent[3/] crude protein
	Bromegrass		
Bromus biebersteinii	Regar	3.10c	16.8c
inermis	Baylor	2.67bc	18.1c
	Blair	3.43c	11.7ab
	Lincoln	2.99bc	15.1bc
	Manchar	2.21ab	11.1a
pumpellianus	Polar	1.66a	17.9c
	Orchardgrass		
Dactylis glomerata	Comet	3.44def	16.8b
	Dayton	3.67ef	14.9a
	K8-119	2.65bc	15.8ab
	Latar	2.78bcd	16.9b
	Napier	2.10ab	16.0ab
	Nordstern	2.55bc	16.9b
	Orbit	3.01cde	15.1a
	OX-1	3.99f	15.4a
	Pomor	1.78a	18.5c
	Tall fescue		
Festuca arundinacea	Alta	3.10a	18.2a
	Clarine	6.43b	17.1a
	Fawn	5.32ab	17.7a
	Reed canarygrass		
Phalaris arundinacea	Rise	2.00a	26.7a
	Vantage	2.89a	23.5a
	Timothy		
Phleum pratense	Climax	4.21b	17.2a
	Itasca	1.55a	19.6a
	Timfor	1.78a	19.1a
	Toro	2.66ab	19.7a

1/ Values within species or plant type followed by the same letter are not significantly different at $P<0.05$.

2/ Two cuttings were made, June 27 and August 10.

3/ Analyses were from regrowth harvested August 10.

Table 7. Crude protein and nitrate concentrations in reed canarygrass harvested at different stages of growth, 1973.

Date of harvest	Stage of growth	Percent crude protein[1/]	Percent NO_3-N[1/]
May 23	Leaf	16.8b	0.10c
June 1	Preboot	15.6b	0.14d
June 7	Boot	15.1b	0.14d
June 21	Early head	9.1a	0.07bc
June 26	Head	9.0a	0.01ab
July 17	Dryhead	4.9a	0.00a
July 17	Leaf regrowth[2/]	17.4b	0.05ab

1/ Values followed by the same letter are not significantly different at $P<0.05$.

2/ Regrowth from plants previously harvested June 10.

Table 8. Yields of alfalfa cultivars planted in 1969.

Cultivar	Hay yields in tons/acre								Avg.[1/]
	1970	1971	1972	1973	1974	1975	1976	1977	
AS-49	1.68	2.91	4.31	4.09	5.20	4.17	3.11	2.44	3.49cd
AS-63	2.07	3.11	4.47	4.26	4.44	3.71	4.15	3.01	3.65cde
Cayuga	2.23	3.14	4.60	4.46	5.37	3.94	4.77	3.45	4.00ef
Culver	1.99	3.18	4.04	3.80	5.58	4.86	3.46	3.47	3.80def
DuPuits	2.70	3.05	3.62	3.62	5.68	4.98	3.70	2.91	3.78def
Grimm	2.58	3.20	4.42	4.38	5.28	4.83	3.89	2.59	3.89def
Ladak	2.22	3.26	4.18	4.56	3.99	4.48	3.64	2.96	3.66cdef
Lahontan	2.27	2.61	4.53	4.18	4.68	3.55	2.84	1.74	3.30bc
Moapa-69	0.94	2.09	2.51	2.22	1.40	1.92	1.69	1.33	1.76a
Narragansett	1.88	3.55	4.65	4.32	5.55	3.54	5.29	3.87	4.08f
Nomad	2.00	3.11	3.51	3.03	3.50	3.90	2,78	4.21	3.25bc
Promor	2.19	3.34	4.51	4.96	5.45	4.60	4.18	3.41	4.08f
Rambler	1.13	2.97	3.67	3.65	3,87	2.97	2.69	3.18	3.02b
Ranger	1.98	3.24	4.15	4.42	5.99	4.52	3.76	2.99	3.88def
Resistador	1.60	3.07	4.24	4,83	6.10	5.03	4,14	2.35	3.92def
Teton	2.51	3.19	3.96	4.51	4.78	4.36	3.99	3.51	3.85def
Uinta	2.45	3.16	4.32	4.60	5.55	4.59	4.29	3.24	4.02ef
Vernal	1.48	3.09	4.20	4.11	4.72	3.78	4.36	3.10	3.60cde
WL303	2.00	3.37	4.44	4.68	4.79	4.22	3.97	3.56	3.88def

1/ Mean values followed by the same letter are not significantly different at $P<0.05$.

Table 9. Crude protein concentration in herbage of alfalfa cultivars at two cutting dates, 1972.

Cultivar	Percent crude protein[1/]	
	July 14[2/]	August 24
AS-49	17.5a	16.2a
AS-63	24.2efg	20.6def
Cayuga	20.2bc	17.0a
Culver	21.3bc	19.3cd
DuPuits	19.7b	18.7bc
Grimm	23.5def	19.6cd
Ladak	22.6de	21.1ef
Lahontan	17.2a	16.2a
Moapa-69	21.5bcd	17.5ab
Narragansett	26.3h	18.9bc
Nomad	21.8cd	22.7g
Promor	23.5def	17.1a
Rambler	22.1cde	20.1cde
Ranger	24.7fg	17.6ab
Resistador	27.4h	16.7a
Teton	21.0bc	22.1fg
Uinta	19.5b	19.7cd
Vernal	22.2cde	20.5def
WL 303	25.2fg	19.0bc

1/ Values within dates followed by the same letter are not significantly different at $P<0.05$.

2/ Regrowth from plants previously harvested June 6.

Table 10. Recovery response of alfalfa cultivars after harvesting.

Cultivar	Height of regrowth after cutting[1/] June 28	July 7	July 14	Relative[2/] recovery rating, 1973
	(----------Inches----------)			
AS-49	6.0	16.0	23.5	7.5
AS-63	5.0	13.5	21.5	5.8
Cayuga	6.0	14.0	19.5	7.8
Culver	3.5	12.0	15.5	4.0
DuPuits	6.5	18.0	22.5	8.2
Grimm	4.7	12.5	18.5	7.5
Ladak	4.0	10.0	15.0	5.8
Lahontan	9.0	21.0	24.5	9.0
Moapa-69	9.5	22.0	25.0	10.0
Narragansett	5.5	13.5	19.0	6.0
Nomad	2.0	7.5	12.5	2.8
Promor	5.5	14.5	20.0	7.5
Rambler	2.5	7.0	12.5	3.2
Ranger	4.5	13.5	19.5	8.3
Resistador	7.5	16.0	24.5	8.0
Teton	3.0	8.0	14.5	5.0
Uinta	3.5	12.0	17.5	5.2
Vernal	3.5	10.0	16.0	5.2
WL303	6.5	16.0	21.5	7.2

1/ Regrowth of plants previously harvested June 6.

2/ Rating based on relative height and vigor, scale 1 low to 10 high.

Table 11. Stand ratings, vigor, and yield of alfalfa cultivars planted in 1973.

Cultivar	Percent stand		Vigor rating[1/]	Herbage yields tons/acre[2/]				Avg[3/]
	1973	1974	1974	1974	1975	1976	1977	
Action	95	94	5.5	5.32	4.68	5.81	4.80	5.15fgh
Agate	89	91	5.2	4.91	4.77	5.17	4.10	4.73de
Apalachee	89	90	7.5	6.09	5.38	4.63	3.81	4.98efgh
Beltsville-72	89	90	6.8	5.86	5.43	5.15	4.18	5.15fgh
DuPuits	94	89	8.0	5.32	5.26	4.77	4.14	4.87def
Gladiator	86	90	4.5	5.77	4.48	4.53	4.55	4.83def
Haymaker	94	94	6.2	5.74	4.07	5.00	4.26	4.76de
Lahontan	89	87	9.0	5.12	3.91	4.07	3.56	4.16c
Moapa-69	94	72	9.5	2.63	3.55	2.26	2.26	2.67a
Narragansett	85	81	5.6	6.22	4.31	4.48	4.44	4.86def
N7-5	94	95	4.5	5.22	4.60	4.70	4.38	4.72de
Orenburg	88	92	2.5	4.86	4.82	4.32	4.06	4.51cd
Polar I	92	96	7.0	5.68	6.02	5.56	4.44	5.42h
Promor	89	89	6.2	5.61	5.58	5.01	4.08	5.07efgh
Saranac	94	94	7.5	5.32	5.15	4.75	4.10	4.83def
Spredor	92	91	4.0	5.26	5.19	4.68	4.27	4.85def
Team	90	90	5.0	5.30	4.82	4.81	4.17	4.77de
Thor	92	96	6.8	6.01	5.82	5.13	4.28	5.31gh
Valor	94	98	4.8	5.56	4.51	5.27	4.75	5.02efgh
Vernal	92	88	4.8	5.05	5.61	4.71	4.31	4.92defg
Washoe	94	98	6.8	5.00	4.55	4.39	4.17	4.52cd
919 Brand	85	80	6.5	5.10	2.86	2.57	3.88	3.60b

1/ Vigor ratings 1 = poor, 10 = good.

2/ Yields in 1974 were from 3 cuttings; all others were from 2 cuttings.

3/ Mean values followed by same letter are not significantly different at $P<0.05$.

Table 12. Crude protein concentration in herbage of selected alfalfa cultivars in 1973 planting.

Cultivar	Percent crude protein			
	May 15[1/]	June 6[1/]	July 12[2/]	August 23[3/]
Agate	20.3	19.0	20.1	20.3
Beltsville-72	19.5	17.8	18.2	18.9
DuPuits	20.1	18.2	16.7	17.6
Lahontan	19.1	18.8	18.9	18.4
Moapa-69	22.2	18.8	16.9	18.7
Promor	20.7	19.3	18.2	20.3
Saranac	21.3	20.2	19.6	17.1
Vernal	20.6	18,6	17.4	18.2
Washoe	19.0	18.4	17.3	17.3
919 Brand	21.6	19.1	18.7	20.3

1/ Plants were not harvested previously to sampling date.

2/ Regrowth from previous sampling date, June 6, 1974.

3/ Regrowth from sampling date, July 12, 1974.

Table 13. Yield of alfalfa cultivars from a 1976 planting.[1/]

Cultivar	June 23	August 10	Total Yield
	tons per acre		
Action	2.76	1.46	4.22
Apollo	2.93	1.84	4.77
Atlas	2.73	1.82	4.55
Culver	2.91	1.26	4.17
Grimm	3.19	1.57	4.76
Haydak	3.24	1.87	5.11
Haymaker	2.87	2.14	5.01
Iroquois	3.09	1.96	5.05
K4-120	2.58	2.10	4.68
Lancer	3.20	1.59	4.79
Marathon	2.89	1.86	4.75
Olympic	2.85	2.12	4.97
Pacer	3.19	2.19	5.38
Polar 1	2.46	2.14	4.60
Promor	2.47	1.77	4.24
Resistador	2.40	1.80	4.20
Thor	2.83	2.44	5.27
Valor	3.00	2.13	5.19
Vernal	2.96	2.04	5.00
Victor	3.14	2.14	5.28
622	3.01	2.02	5.03

[1/] Harvested in 1977.

Table 14. Stand establishment and herbage yield of miscellaneous legume cultivars planted in 1973.

Species	Cultivar	Percent stand 1973	Yield in tons/acre 1974	1975	1976	1977
Astragalus cicer	-	65	1.69	2.33	2.05	1.79
Coronilla varia	Chemung	15	0.02	-	-	-
Lotus corniculatus	Cascade	88	4.80	1.98	1.58	2.06
	Empire	85	3.45	3.06	1.77	1.86
	Granger	85	3.88	2.22	1.50	1.89
	Mansfield	78	3.16	3.55	1.92	2.18
Medicago littoralis	-	88	-	-	-	-
Onobrychis viciifolia	Eski	70	1.66	2.33	1.99	1.72
	Onar	75	3.69	1.82	1.78	1.68
Trifolium fragiferum	Palestine	90	-	-	-	-
	Salina	90	-	-	-	-
T. hybridum	Aurora	90	1.88	0.94	0.17	0.26
T. pratense	Altasweet	85	4.53	4.39	1.97	2.70
	Kenland	90	4.76	3.59	2.47	2.59
	K9-119	90	4.80	4.14	3.04	3.46
	Ulva	90	4.35	3.23	2.41	2.00
T. repens	KO-176	80	2.15	1.87	0.92	0.72
	New Zealand	85	3.09	1.86	1.98	2.20

Table 15. Herbage yield of alfalfa and grasses alone and in hay mixtures, 1977.

Species and mixtures	Hay yields tons/acre				Total yield [1/]
	June 27		August 10		
	Alfalfa	Grass	Alfalfa	Grass	
Promor alfalfa	3.11	-	2.00	-	5.11cd
Regar brome	-	3.66	-	0.77	4.43bc
Manchar brome	-	3.39	-	0.32	3.71ab
Latar orchardgrass	-	2.71	-	0.74	3.45a
Fawn tall fescue	-	2.63	-	0.76	3.39a
Alfalfa-Regar	3.09	0.34	1.84	0.56	5.83d
Alfalfa-Manchar	3.01	0.34	1.59	0.12	5.06cd
Alfalfa-Latar	2.63	0.46	1.72	0.54	5.35d
Alfalfa-Fawn	1.98	0.51	1.29	0.55	4.33bc

1/ Total yield values followed by the same letter are not significantly different at $P<0.05$.

Table 16. Crude protein concentration in herbage to alfalfa, grass, and mixed hay, 1977.

Species and mixtures	Percent crude protein			
	June 27		August 10	
	Alfalfa	Grass	Alfalfa	Grass
Promor alfalfa	15.1	-	16.6	-
Regar brome	-	11.6	-	16.5
Manchar brome	-	10.2	-	19.2
Latar orchardgrass	-	10.5	-	12.2
Fawn tall fescue	-	8.4	-	10.3
Alfalfa-Regar	14.1	12.9	16.7	15.2
Alfalfa-Manchar	15.8	9.4	19.7	18.0
Alfalfa-Latar	15.4	11.6	17.5	15.2
Alfalfa-Fawn	15.8	8.5	16.6	15.0

Table 17. Performance of yearling herfords on irrigated pastures.

Pasture mixture	Animal sex	Stocking rate per acre	Grazing period	ADG	Gain per head	Gain per acre
					(----pounds-----)	
Tall fescue-alfalfa	heifer	3	5/7-8/27	1.7	221	664
Tall fescue-clover	heifer	3	5/7-8/27	1.6	202	603
Orchardgrass-alfalfa	steer	3	5/17-8/1	1.9	144	432
Tall fescue-alfalfa	steer	3	4/17-8/1	1.4	106	318

Table 18. Performance of weaned calves on irrigated pasture, 1977.

Pasture mixture	Stocking rate	Grazing period	ADG	Gain per head	Gain per acre
				(----------pounds----------)	
Calves weaned in early spring					
Orchardgrass-clover	6	5/17-8/1	1.93	147	882
Tall fescue-clover	6	5/17-8/1	1.56	119	714
Orchardgrass-alfalfa	4	8/1-10/4	1.89	121	484
Tall fescue-alfalfa	4	8/1-10/4	1.34	86	344
Calves weaned in late July					
Orchardgrass-alfalfa	4	8/1-10/4	1.06	68	274
Tall fescue-alfalfa	4	8/1-10/4	0.73	47	188