Performance of Perennial Forage Legumes in Northern Idaho

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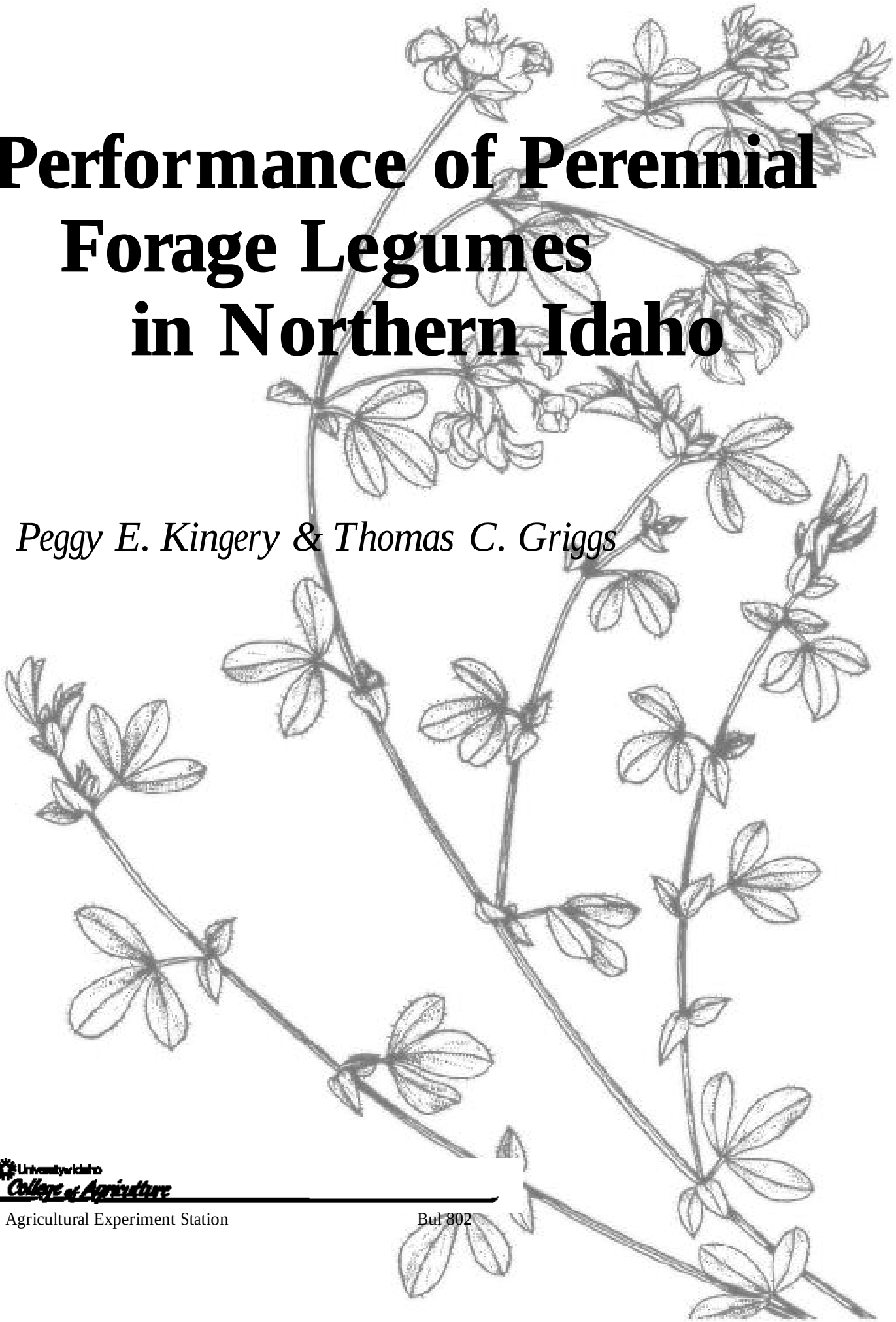

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Perennial forage legumes are a valuable component of sustainable cropping systems in northern Idaho. While grasses are the predominant forage species in the region, the benefits of legumes include: 1) the ability to fix atmospheric nitrogen (N_2), which reduces the need for N fertilizer; 2) higher nutritive value than found in grasses fertilized with N; 3) increased potential profitability; and 4) wider seasonal distribution of high-quality forage. Legumes have higher concentrations of digestible energy than grasses. Animal performance is therefore enhanced when ruminant livestock ingest diets with a large legume component. Including the tap-rooted legumes in pastures may extend the grazing season further into the dry summer period than is possible with grasses alone.

Many perennial legumes are adapted to northern Idaho's environmental conditions and livestock needs. Tap-rooted species such as alfalfa and red clover continue to grow during periods of low summer rainfall. Alsike clover tolerates the acidic conditions of cut-over forest soils. Kura clover, a rhizomatous species, survives extremes of drought and cold. Livestock producers appreciate the stoloniferous nature and high feeding value of white and ladino clovers and the non-bloating characteristic of sainfoin, cicer milkvetch, and birdsfoot trefoil. Because cultivars differ in suitability to environmental conditions, production potential, seasonal growth distribution, establishment ease, persistence, and utilization schemes, producers have a range of plant materials with which to meet their management objectives.

The lack of cultivar performance information for northern Idaho dryland conditions led to initiation of a multispecies variety trial. Objectives were to assess the productivity, seasonal growth distribution, and longevity of forage legumes under hay management. This work summarizes data collected from three growing seasons.

Methods

Fifty cultivars, representing ten species, were evaluated. Entries ranged in establishment rate, environmental adaptation, risk of bloat induction, growth form (tap-rooted or spreading, upright or prostrate), hardiness (cold and drought), pest- and disease-resistance, canopy leaf area, and fall dormancy rating.

Experimental plots were seeded in Latahco silt loam soil at the University of Idaho Parker Farm, Moscow, in May 1994, with certified seed of public or proprietary cultivars. Annual precipitation was higher in all years of the study than the long-term average, particularly in the fall, winter, and spring months (Fig. 1). During the active growing season, April through August, precipitation amounted to 6.6, 10.0, 10.9, and 11.0 in. for 1994 through 1997, respectively, as compared to the 30-year mean of 10.6 in. Monthly mean temperatures were similar to long-term averages in all years (Fig. 2).

Previous crops on the site had been perennial grasses

Figure 1. Monthly mean precipitation for Moscow, ID, 1993–97 and 30-year (1961–90) mean.

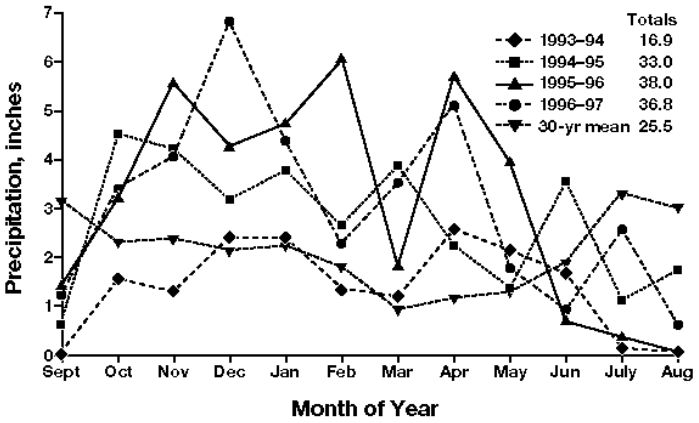
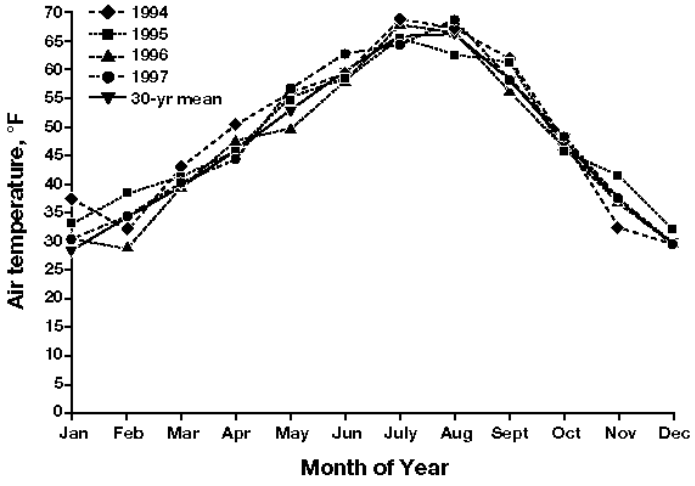


Figure 2. Monthly mean temperature for Moscow, ID, 1994–97 and 30-year (1961–90) mean.



or legumes. Seedbeds were prepared by harrowing and cultipacking. Benefin pre-emergent herbicide was incorporated in the soil at 1.25 lb ai/ac prior to seeding to suppress annual grasses and broadleaf weeds. Cicer milkvetch and kura clover seeds were scarified to improve germination. Seeds were inoculated with the appropriate Rhizobium bacteria for each species (Mahler et al. 1988).

Table 1. Seeding rates for entries

Species	Seeding rate
	lb bulk seed/ac
alfalfa	8
birdsfoot trefoil	8
big trefoil	4
sainfoin (with hulls)	31
cicer milkvetch	13
red clover	6
white/ladino clover	4
alsike clover	5
kura clover	5
chicory	5

Entries were drill-seeded in four replicate 4.3- x 11.5-ft. plots arranged in randomized complete blocks. Seed was placed 0.5 in. deep in rows spaced 7 in. apart. Bulk seeding rates (Table 1) were calculated to deliver 30-60 pure live seeds/ft^2. Fertilizer applications, based on biennial soil testing, met recommendations in the UI extension soil fertility bulletin for alfalfa (Mahler and Tindall 1994). Soil pH at the site was 5.8; adequate levels of phosphorus, potassium, and boron (10 ppm P, 201 ppm K, and 0.7 ppm B) were present. Sulfur was deficient (2 ppm SO_4-S) and was applied as gypsum when required. Grasslands Puna chicory, a non-leguminous perennial broadleaf, received supplemental N each spring (Table 2). The presence of annual and perennial broadleaf weeds in two replicates in the establishment year resulted in poor stand density. Data were therefore collected from only the remaining two replicates in the first production year. Stand density eventually improved such that data were gathered from three replicates after the first year. Weeds were controlled by clipping and hand removal.

Table 2. Fertilization and herbicide application history

Date	Rate and source
	lb/ac
9/28/93	43 S, 2 B (borated gypsum)
10/1/93	1.25 benefin
5/23/94	60 N (40-0-0-6) chicory only
4/26/95	80 N (40-0-0-6) chicory only
4/27/95	30 S (gypsum)
4/9/96	80 N (34-0-0) chicory only
4/22/97	80 N (34-0-0) chicory only

Forage was flail-harvested to a 4-in. stubble height from a 34-in. wide swath running the length of each plot. Prior to harvesting, canopy cover (percent of plot ground area covered by forage), weed content (percent of total plot dry matter), and plant growth stage (vegetative to post-flowering) were recorded. Forage was harvested when the majority of alfalfa cultivars had reached the late bud stage of maturity (Table 3). Most of the other species tended to be more mature at harvest. Production data were not collected from plots with less than 65 percent cover and/or greater than 20 percent weed material. First cuttings were taken in mid-June. When second cuttings were taken in mid-July, some clovers had not regrown sufficiently to be harvested. Third cuttings of alfalfa were taken in late Au-

Table 3. Forage legume maturity stages, 1995-1997

		Maturity stage at each cutting											
		1995			1996			1997			Mean		
		1st	2nd	3rd *	1st	2nd	3rd *	1st	2nd	3rd	1st	2nd	3rd
Species	**Cultivar**	14 Jun	21 Jul	8 Sep	17 Jun	26 Jul	24 Sep	6 Jun	16 Jul	27 Aug			
		scale of 2-7 **											
alfalfa	Achieva	4	5	4	4	4	4	4	4	4	4	4	4
alfalfa	Agate	3	4	3	3	3	4	4	4	4	3	4	4
alfalfa	Blazer XL	4	3	4	4	4	4	4	4	4	4	4	4
alfalfa	Class	4	5	4	3	4	nh #	4	4	4	4	4	4
alfalfa	Extend	4	5	4	3	4	nh	4	4	4	4	4	4
alfalfa	Forager	3	4	4	3	4	4	4	4	4	3	4	4
alfalfa	Fortress	4	5	3	3	4	4	4	4	4	4	4	4
alfalfa	Gem	4	4	4	4	4	4	4	4	4	4	4	4
alfalfa	Imperial	4	4	4	3	3	4	4	4	4	4	4	4
alfalfa	Legacy	4	4	4	3	4	nh	4	4	4	4	4	4
alfalfa	Multiqueen	4	5	4	4	4	4	4	4	4	4	4	4
alfalfa	Pacesetter	4	4	4	3	4	4	4	4	4	4	4	4
alfalfa	Rangelander	4	4	4	4	4	4	4	4	4	4	4	4
alfalfa	Ranger	3	5	4	3	3	4	4	4	4	3	4	4
alfalfa	Resistar	4	4	nh	3	4	4	4	4	4	4	4	4
alfalfa	Spredor 3	4	4	4	3	4	4	4	4	4	4	4	4
alfalfa	Vector	3	4	4	3	4	4	4	4	4	3	4	4
alfalfa	WL-225	4	4	4	3	4	4	4	4	4	4	4	4
alfalfa	Wrangler	4	4	4	3	4	4	4	4	4	4	4	4
birdsfoot trefoil	AU-Dewey	6	5	nh	4	4	nh	4	4	4	5	4	4
birdsfoot trefoil	Cascade	6	5	nh	4	5	nh	nh	nh	nh	5	5	nh
red clover	Acclaim	4	3	nh	3	4	nh	nh	nh	nh	3	4	nh
red clover	Arlington	4	3	nh	3	3	nh	nh	nh	nh	4	3	nh
red clover	Greenstar	4	3	nh	3	5	nh	nh	nh	nh	3	4	nh
red clover	Marathon	3	2	nh	3	3	nh	nh	nh	nh	3	3	nh
red clover	Atlas	3	3	nh	3	3	nh	nh	nh	nh	3	3	nh
white clover	Grasslands Pitau	6	7	nh	3	7	nh	nh	nh	nh	4	7	nh
white clover	Star	6	7	nh	6	7	nh	nh	nh	nh	6	7	nh
LSD (0.2)***		1	1	ns	1	1	ns	ns	0	0			
LSD (0.1)		1	1	ns	1	1	ns	ns	0	0			

* Only alfalfa was harvested during these 3rd cuttings.

** Maturity designations: 2=vegetative, 3=early bud, 4=late bud, 5=early flower, 6=late flower, 7=seed.

nh = not harvested.

*** Minimum value required for statistical difference between any two entries within a column.

ns = not significant.

Table 4. Forage dry matter production, cover, and maturity stages of cultivars present only in 1995

Species	Cultivar	Total production*	Canopy cover*	Maturity stage 1st Cut 14-Jun	Maturity stage 2nd Cut 21-Jul
		lb DM/ac	% of ground area	scale of 2-7**	
ladino clover	California	6615	98	5	7
ladino clover	Canopy	6540	90	5	7
alsike clover	Dawn	7003	93	5	6
chicory	Grasslands Puna	15267	94	4	4
birdsfoot trefoil	Norcen	8750	99	4	4
sainfoin	Renumex	7922	89	6	6

* Total production and canopy cover data are based on two harvests.

** Maturity designations: 2=vegetative, 3=early bud, 4=late bud, 5=early flower, 6=late flower, 7=seed.

gust-late September. Dry matter production was expressed as oven-dry (98° F) forage.

Production, cover, weed content, and plant growth stage of cultivars were compared by analysis of variance at a significance level of P = 0.1. Protected least significant differences (LSD) were calculated at 10 and 20 percent levels of probability that cultivar differences were due to chance alone.

Results and Discussion

Establishment of Empire birdsfoot trefoil, Grasslands Tahora and Grasslands Kopu white clovers, Lutana and Monarch cicer milkvetches, and Rhizo kura clover was highly variable among replicates; Grasslands Maku and Marshfield big trefoils did not establish at all. Data pertaining to these cultivars will therefore not be reported. Production, cover, and maturity stage data for other cultivars that persisted only one year are presented in Table 4. Although these latter entries established well, as evidenced by high production and plot coverages, meadow voles and northern pocket gophers severely damaged plots during the winter and spring of 1996, resulting in loss of these stands. This damage was evident throughout the experiment and is reflected in lower forage ground cover in 1996 (Table 5).

Production data for the remaining entries are presented in Table 6. Total season production ranged from 2,693 to 13,842 lb/ac across all years and was highest in 1995, averaging 11,297 lb/ac. All alfalfa entries performed well, producing from 8,096 to 12,573 lb/ac, averaged across years, and averaging greater than 80 percent ground cover over the three years of the study (Table 5). Averages were calculated only for entries that were present in all three years of the study. Production data are in agreement with the 8,000 to 10,000 lb/ac yields reported by Menser and Mancuso (1988) in Sandpoint, Idaho.

Fall dormancy ratings of the highest-producing alfalfa entries ranged from 2 to 4; 2 and 3 describe dormant cultivars while 4 describes semi-dormant. Two of the top ten cultivars, Achieva and Class, possess multifoliolate characteristics. Rangelander is the only cultivar among the highest producers that is creeping-rooted. The other creeping-rooted cultivars, Spredor 3 and Forager, did not perform as well.

Late-summer growth of alfalfas, presumably due to utilization of soil water by deep root systems, allowed for an economic third cutting each year. This cutting contributed 2 to 28 percent of the total season production. The other species in the trial could only be harvested once or twice within a season. Generally, less than 60 percent of the total season production of alfalfa was harvested in the first cutting as compared to an average of 70 percent for

Table 5. Forage legume ground cover, 1995-1997

Species	Cultivar	Season mean cover*			
		1995	1996 +	1997 **	Mean
		% of ground area			
alfalfa	Class	100	96	97	98
alfalfa	Ranger	99	94	97	97
alfalfa	WL-225	98	96	96	97
alfalfa	Achieva	100	92	92	95
alfalfa	Multiqueen	99	94	91	95
alfalfa	Vector	99	91	94	95
alfalfa	Agate	97	92	93	94
white clover	Grasslands Pitau	92	94	•	•
alfalfa	Wrangler	99	86	91	92
alfalfa	Fortress	91	92	92	92
alfalfa	Rangelander	100	91	84	92
alfalfa	Spredor 3	95	85	90	90
alfalfa	Gem	96	84	88	89
red clover	Greenstar	93	85	•	•
white clover	Star	93	84	•	•
alfalfa	Imperial	88	85	92	88
alfalfa	Extend	94	83	87	88
birdsfoot trefoil	AU-Dewey	94	86	82	87
red clover	Atlas	86	88	•	•
alfalfa	Forager	85	86	88	86
red clover	Acclaim	89	81	•	•
alfalfa	Legacy	98	74	83	85
alfalfa	Blazer XL	93	81	73	82
red clover	Marathon	80	84	•	•
birdsfoot trefoil	Cascade	89	73	•	•
alfalfa	Pacesetter	84	74	84	81
alfalfa	Resistar	79	81	82	81
red clover	Arlington	78	80	•	•
Mean, entries common to all years		94	87	89	
LSD (0.2)***		14	17	ns	
LSD (0.1)		18	21	ns	

* Data are averaged across harvests within years. Entries are ranked in order of mean cover across years.

\+ Poor ground cover in 1996 was due to a high amount of rodent damage.

** Missing cover data are due to entry reaching the end of its stand life or a high proportion of weed material.

*** Minimum value required for statistical difference between any two entries within a column.

ns = not significant.

Table 6. Forage legume dry matter production, 1995-1997

Species	Cultivar	Total season production*				Proportion in each cutting		
		1995	1996	1997	Mean	1995	1996	1997
		lb DM/ac				1st/2nd/3rd	1st/2nd/3rd	1st/2nd/3rd
alfalfa	Multiqueen	12858	13725	11134	12573	55/31/14	56/27/17	33/39/28
alfalfa	Rangelander	13842	12345	8711	11633	59/31/10	57/25/18	43/36/22
alfalfa	WL-225	11460	12519	10881	11620	60/33/8	57/30/13	38/35/26
alfalfa	Imperial	11824	11104	11883	11604	55/32/12	59/25/15	38/39/23
alfalfa	Achieva	12812	10698	11168	11559	57/29/14	57/28/15	39/37/24
alfalfa	Vector	12414	10636	10847	11299	58/31/11	58/28/15	39/36/25
alfalfa	Class	11459	11607	10572	11213	55/32/13	60/28/12	39/34/27
alfalfa	Fortress	12643	10820	9840	11101	57/28/15	60/28/12	40/34/26
alfalfa	Extend	11046	•	11129	•	56/32/12	•	40/35/25
alfalfa	Resistar	•	10551	11327	•	•	50/29/21	35/37/28
alfalfa	Ranger	11793	10716	10119	10876	58/31/11	61/27/12	41/34/25
alfalfa	Wrangler	12153	10278	9699	10710	61/30/9	57/28/15	45/32/23
alfalfa	Forager	•	11254	9702	•	•	56/29/15	36/39/25
alfalfa	Agate	10236	10219	10011	10155	60/33/7	63/25/12	43/36/22
alfalfa	Blazer XL	8111	11423	•	•	62/31/7	52/31/17	•
alfalfa	Legacy	9844	•	9619	•	62/31/7	•	40/37/23
red clover	Greenstar	9280	9493	•	•	74/26/0	83/17/0	•
alfalfa	Gem	10330	8655	8890	9292	64/32/5	60/27/13	38/41/21
alfalfa	Spredor 3	8709	8110	10187	9002	69/29/3	73/24/3	43/35/22
alfalfa	Pacesetter	7778	7121	9388	8096	67/32/2	55/25/9	40/36/24
red clover	Acclaim	7595	8547	•	•	72/28/0	83/17/0	•
red clover	Atlas	7388	8665	•	•	77/23/0	83/17/0	•
red clover	Marathon	6640	8466	•	•	75/25/0	82/18/0	•
red clover	Arlington	6447	7305	•	•	77/23/0	86/14/0	•
birdsfoot trefoil	AU-Dewey	9143	5543	5724	6803	65/35/0	72/28/0	49/35/16
birdsfoot trefoil	Cascade	7424	4852	•	•	67/33/0	77/23/0	•
white clover	Star	6997	2693	•	•	70/30/0	100/0/0	•
white clover	Grasslands Pitau	4484	4075	•	•	57/43/0	100/0/0	•
Mean, entries common to all years		11297	10273	9937				
LSD (0.2)**		2655	2687	2075				
LSD (0.1)		3431	3472	2688				

* Data excluded if mean cover < 65% and/or mean weed content > 20% within a year. Entries are ranked in order of mean production across years.

** Minimum value required for statistical difference between any two entries within a column.

the other legumes and 65 to 90 percent for perennial forage grasses (Griggs and Kingery, 1998).

Although most of the alfalfa grown in Idaho is irrigated, its ability to withstand droughty conditions suits it to dryland production. For maximum yield, alfalfa requires a soil pH of 6.5-7.0. The predominantly acidic soils in northern Idaho may therefore limit its performance unless lime is applied. Entries evaluated in this trial are a subset of dozens of certified cultivars that are available for planting in northern Idaho. These possess varying levels of disease- and pest-resistance and fall dormancy ratings (1 to 5), giving the grower a wide selection with which to meet management objectives. A good source of information about alfalfa cultivars is an annual list produced by the Certified Alfalfa Seed Council.

AU-Dewey birdsfoot trefoil was the only non-alfalfa entry for which data are reported in 1997 (Table 6). The other birdsfoot trefoil entry, Cascade, and the white clovers, Star and Grasslands Pitau, produced well in the first two years, but rodent damage and/or a high percent of weed material precluded data collection in 1997. Production levels for birdsfoot trefoil were comparable to yields reported by Menser and Mancuso (1988) and Hall et al. (1988) in Sandpoint, Idaho. Birdsfoot trefoil can be established on a wide variety of soil types and tolerates infertile, waterlogged, acid, or mildly alkaline conditions. Two growth forms exist: a prostrate type such as AU-Dewey and a more erect type such as Cascade. Both types establish relatively slowly, but are persistent and productive when seeded in pasture with grass, provided they are not heavily grazed.

White clover is likewise widely-adapted to a variety of soil conditions provided soil water is adequate. Maximum yield is obtained when sown in clay and loam soils with a pH between 6.0 and 6.5. Like birdsfoot trefoil, several types are available based on leaf size: small, intermediate, and large, often termed 'ladino.' Both Star and Grasslands Pitau fall in the intermediate class. Ensign (1987) reported slightly higher yields for Star in Moscow than were found in this study. White clover is generally seeded with grass, preferably a bunch-type.

The red clover entries produced from 6,876 to 9,386 lb/ac, averaged across the first two years (Table 6). By year three, plots had become too sparse to harvest, reflective of this species' short life cycle. For maximum yield, red clover requires fertile, well-drained soils with a pH greater than 6.0. Both single- and double-cut cultivars are available; those planted in this trial were all double-cut types. Red clover is used extensively in pasture mixtures and for renovating old pastures. Because it is shade-tolerant, it is one of the easiest legumes to establish in grass sods.

Conclusions

The benefits of legumes in pasture and hay enterprises cannot be overlooked when choosing among the myriad of forage species available for planting. Choose a cultivar that is adapted to the site environmental conditions and, if seeding in a mixture, match the cultivar with a compatible grass species. For information on grass cultivar performance, refer to Griggs and Kingery (1998).

In this study, the alfalfas produced the greatest quantity of forage and persisted longer than the other species planted, due in part to an ability to compete with weeds and damaging pests. Red clover, as a short-lived perennial, produced abundant forage for only two years. Birdsfoot trefoil and white clover generally remain productive for greater than two years; however, weed competition and rodent damage reduced their longevity.

To capture the potential benefits of legumes, the grower or producer must be an astute manager. Maintaining adequate soil fertility through regular soil testing and application of appropriate fertilizer materials, and managing for insect and mammal pests, will ensure productive, long-lasting legume stands that are better able to compete with weeds and withstand damage from insects. In areas where annual legumes such as peas or lentils are grown, insect populations may be high and use of pesticides to prevent damage to perennial legume stands may be necessary.

References

Ensign, R. D. 1987. Star white clover. Univ. of Idaho Agric. Exp. Stn. Bull. 670.

Griggs, T. C. and P. E. Kingery. 1998. Performance of forage and conservation grasses in northern Idaho. Univ. of Idaho Agric. Exp. Stn. Bull. 798.

Hall, M. H., M. J. Dial, and R. L. Mahler. 1988. Birdsfoot trefoil production in northern Idaho. Univ. of Idaho Agric. Exp. Stn. Curr. Info. Ser. 831.

Mahler, R. L. and T. A. Tindall. 1994. Northern Idaho fertilizer guide: alfalfa. Univ. of Idaho Agric. Exp. Stn. Curr. Info. Ser. 447 (revised).

Mahler, R. L., G. E. Kleinkopf, and M. H. Hall. 1988 Inoculation of legumes in Idaho. Univ. of Idaho Agric. Exp. Stn. Curr. Info. Ser. 838.

Menser, H. A. and C. J. Mancuso. 1988. Varietal performances of forage crops in northern Idaho. Univ. of Idaho Agric. Exp. Stn. Bull. 679.

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