FORAGE YIELD AND QUALITY OF MULTIFOLIOLATE ALFALFA

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ABSTRACT

A two-year field study was conducted in western South Dakota to evaluate forage yield and quality of trifoliolate and multifoliolate alfalfa (*Medicago sativa* L.) cultivars. Trifoliolate cultivars have three leaflets per leaf. Multifoliolate cultivars may have plants that possess four or more leaflets per leaf. Eight trifoliolate and six multifoliolate cultivars were evaluated for dry matter forage yield, crude protein concentration, neutral detergent fiber, and acid detergent fiber at one cutting in 1990 and three cuttings in 1991. No significant differences were detected among cultivars for any of the yield or quality parameters for 1990 or 1991. Mean forage yields were 5248, 4391, and 3509 kg ha^{-1} for the first, second, and third cuttings in 1991, respectively. Mean crude protein concentrations ranged from 188 g kg^{-1} for the first cutting to 201 g kg^{-1} for the second. Results indicate that with the cultivars used in this study, the multifoliolate trait appears to offer no advantage in forage yield or quality over the trifoliolate.

INTRODUCTION

The multifoliolate trait of alfalfa (*Medicago sativa* L.), which results in leaves with more than three leaflets per leaf, has been known for more than 50 years (Bingham, 1966). Previous studies have investigated multifoliolate alfalfa leaf anatomy (Bingham, 1966), plant morphology (Bingham and Murphy, 1965), and photosynthetic attributes (Etzel et al., 1988). Forage yields of widely spaced multifoliolate genotypes have been less than or equal to that of trifoliolate genotypes (Ferguson and Murphy, 1973; Volenec and Cherney, 1990). However, the proportion of leaf tissue in herbage dry weight has usually been greater for multifoliolate genotypes (Ferguson and Murphy, 1973).

When grown under controlled environmental conditions, Etzel et al. (1988) observed that multifoliolate selections averaged 4.1 to 7.3 leaflets per leaf and had up to a threefold greater area per leaf than trifoliolate phenotypes. After ten days of regrowth, plant leaf area development was greater for phenotypes selected for seven or nine leaflets per leaf than for trifoliolate phenotypes. In several studies, multifoliolate plants were found to have higher leaf/stem ratios than trifoliolate plants (Ferguson and Murphy, 1973; Etzel et al., 1988; Volenec and Cherney, 1990). Higher leaf/stem ratios are associated with higher herbage digestibility (Volenec and Cherney, 1990). These authors also found herbage crude protein concentrations of multifoliolate plants were not consistently greater than that of trifoliolate plants.

All previous studies reviewed have evaluated forage yield or quality characteristics of multifoliolate plants selected for consistent expression of the multifoliolate trait. Within the past five years, several commercial multifoliolate alfalfa cultivars have been released for which the expression of this trait is not as consistent as that of the experimental germplasm (Volenec and Cherney, 1990). Information regarding the forage yield and quality characteristics of these commercially-available multifoliolate cultivars is lacking. This field study was conducted to compare the forage yield and quality of multifoliolate cultivars to trifoliolate cultivars commonly grown in the northern Great Plains.

MATERIALS AND METHODS

The study was conducted during 1990 and 1991 near Nisland, SD on a Glenberg fine sandy loam (coarse-loamy, mixed, mesic, Ustic Torrifluvent) soil. The eight trifoliolate alfalfa cultivars used were Chief, Agate, Super 740, Elevation, 5364, Vernal, DK 120, and Dart. The six multifoliolate cultivars used were Multi-plier, MultiKing 1, Legend, 2833, 5333, and Crown II. The trifoliolate cultivars are commonly grown for forage in the northern Great Plains region. The multifoliolate cultivars have not been extensively evaluated in this region. All cultivars were seeded on April 12, 1990 at a rate of 12 kg pure live seed ha^{-1}. Immediately prior to seeding, EPTC (S-ethyldipropylthio-carbamate) herbicide was applied at a rate of 3.4 kg active ingredient ha^{-1} and incorporated to a depth of 10 cm using a field cultivator. Phosphorus fertilizer was applied at a rate of 150 kg ha^{-1} prior to seeding and incorporated at the same time as the herbicide. Plot size was 2.1 x 7.6 m. Experimental design was a randomized complete block with three replicates. Cuttings were taken September 19, 1990, and June 10, July 23, and August 29, 1991. All culitvars were approximately in the early flower stage for each harvest, with the exception of the June 10, 1991, harvest. At this sampling date plants were in about the 50% bloom stage. At each harvest date, a 0.9 x 4.3 m strip was taken from the center of each plot with a sickle bar mower to determine forage yield. Herbage was weighed and a representative subsample (about 0.45 kg) collected, weighed, and dried at 60^0 to constant weight. Herbage dry matter

yield was calculated using total plot fresh weight and dry matter concentration data. Subsamples were sequentially ground to pass through a 2 mm shear mill screen and a 1 mm impact mill screen. Total Kjeldahl nitrogen and acid detergent fiber (ADF) were measured as outlined by A.O.A.C. (1990). Crude protein (CP) concentration was calculated as total nitrogen x 6.25. Neutral detergent fiber (NDF) concentration was determined using the Goering and Van Soest (1970) procedure. Data were analyzed using analysis of variance for a randomized complete block design (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

For the one cutting obtained in 1990 significant differences ($P<0.05$) among cultivars were not apparent for any of the forage yield or quality parameters (Table 1). This result was not unexpected. Seeding year alfalfa yield data are usually variable (Twidwell et al., 1991). Coefficients of variation ranged from 7.3% for NDF to 16.1%

Table 1. Forage yield, crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) of 14 alfalfa cultivars harvested Sept. 19, 1990.

Cultivar	Yield	CP	NDF	ADF
	kg ha^{-1}	g kg^{-1}		
Trifoliolate				
Chief	2482	196	379	314
Agate	2705	198	370	304
Super 740	2779	188	402	343
Elevation	2606	199	375	314
5364	2266	189	375	313
Vernal	2415	199	363	314
DK 120	2647	194	383	322
Dart	2498	202	369	311
Multifoliolate				
Multi-plier	2894	195	378	315
MultiKing 1	2480	194	372	310
Legend	3024	194	374	310
2833	2827	196	368	315
5333	2880	199	365	302
Crown II	2838	196	366	311
Mean	2667	196	374	314
P > F	0.25	0.30	0.32	0.28
CV (%)	16.1	7.8	7.3	7.4

for forage yield. These values are relatively high and may explain the lack of significance among cultivars.

During 1991 three cuttings were obtained. Significant cultivar differences ($P<0.05$) were not detected for any of the forage yield or quality parameters (Tables 2, 3, and 4) at any of the sampling dates. For the first cutting, cultivar differences in CP and NDF concentrations were significant at the 0.11 and 0.17 probability levels, respectively (Table 2). The multifoliolate cultivars averaged 8.2 g kg^{-1} higher in CP concentration and 10.5 g kg^{-1} lower in NDF than the trifoliolate cultivars. These differences were not significant at the 0.10 level. This slight advantage for the multifoliolate cultivars in CP concentration and NDF was not apparent for the other two cuttings. Mean forage yields were 5248, 4391, and 3509 kg ha^{-1} for the first, second, and third cuttings, respectively. The higher yield for the first cutting was attributed to harvesting at a later maturity stage. Later

Table 2. Forage yield, crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) of 14 alfalfa cultivars harvested June 10, 1991.

Cultivar	Yield	CP	NDF	ADF
	kg ha^{-1}		g kg^{-1}	
Trifoliolate				
Chief	5145	183	470	395
Agate	5513	188	468	388
Super 740	5121	183	486	407
Elevation	5454	183	485	403
5364	5257	184	478	397
Vernal	4757	188	477	400
DK 120	5433	182	478	408
Dart	5156	182	474	399
Multifoliolate				
Multi-plier	5452	190	466	392
MultiKing 1	5152	194	461	387
Legend	5547	192	471	393
2833	5365	192	471	399
5333	4999	191	471	405
Crown II	5126	194	459	397
Mean	5248	188	473	398
P > F	0.30	0.11	0.17	0.24
CV (%)	11.3	3.2	2.3	2.4

Table 3. Forage yield, crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) of 14 alfalfa cultivars harvested July 23, 1991.

Cultivar	Yield	CP	NDF	ADF
	kg ha^{-1}		g kg^{-1}	
Trifoliolate				
Chief	4539	202	445	375
Agate	4446	205	444	368
Super 740	4038	202	441	380
Elevation	4286	203	441	373
5364	4618	196	458	383
Vernal	4159	200	452	377
DK 120	4630	201	455	383
Dart	4284	198	453	382
Multifoliolate				
Multi-plier	4180	204	442	374
MultiKing 1	4241	205	448	374
Legend	4157	213	441	370
2833	4879	193	465	387
5333	4454	195	460	387
Crown II	4564	198	465	394
Mean	4391	201	451	379
P > F	0.24	0.36	0.23	0.23
CV (%)	10.9	4.0	2.9	2.8

cutting also influenced herbage CP, as mean CP concentration was 188 g kg^{-1} for the first cutting compared to 201 and 198 g kg^{-1} for the second and third cuttings, respectively. It has been well documented that as alfalfa matures, forage yield increases and quality decreases (Smith, 1964). Coefficients of variation for yield and all quality parameters for each cutting in 1991 were lower than those obtained during the seeding year. This finding reinforces the concept that seeding-year alfalfa data is more variable than that obtained from established stands. Results of this study are in agreement with those of Volenec and Cherney (1990) and Juan et al. (1991). In both studies herbage CP concentrations of multifoliolate and trifoliolate alfalfa phenotypes were found to be similar. Juan et al. (1991) found one of the multifoliolate entries to be significantly higher in forage yield compared to the other entries when cut at the bud maturity stage three times per year. When cut twice per year at the flower maturity stage,

Table 4. Forage yield, crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) of 14 alfalfa cultivars harvested August 29, 1991.

Cultivar	Yield	CP	NDF	ADF
	kg ha^{-1}	———	g kg^{-1}	———
Trifoliolate				
Chief	3509	197	414	366
Agate	3574	209	401	355
Super 740	3349	201	418	363
Elevation	3508	195	418	361
5364	3560	193	425	363
Vernal	3185	201	408	345
DK 120	3787	198	410	351
Dart	3410	198	410	355
Multifoliolate				
Multi-plier	3583	197	421	364
MultiKing 1	3705	193	427	371
Legend	3413	194	427	369
2833	3428	198	428	366
5333	3630	197	427	365
Crown II	3489	202	417	365
Mean	3509	198	418	361
P > F	0.18	0.23	0.20	0.18
CV (%)	9.0	4.6	4.3	4.8

no significant cultivar differences were detected. In general forage yield results from this study are in agreement with Juan et al. (1991). Yield of multifoliolate cultivars was at least equal to that of the trifoliolate cultivars. These results differ from previous studies (Ferguson and Murphy, 1973; Volenec and Cherney, 1990). Herbage yields were usually found to be lower for multifoliolate phenotypes. These studies, however, measured herbage yield of material grown in space-planted plots. When seeded in solid stands, yield advantage of the trifoliolate cultivars appears to be diminished. The current study appears to be the first to document and compare NDF and ADF concentrations of multifoliolate and trifoliolate alfalfa cultivars. Results suggest multifoliolate cultivars currently being marketed offer no significant advantages in forage quality characteristics over trifoliolate cultivars. One factor that may affect the quality of these multifoliolate cultivars is level of expression of this trait. Juan et al. (1991) reported that the percentage of plants having at least one

multifoliolate leaf varies from 5 to 78% among cultivars. Bingham and Murphy (1965) postulated that genes at three independent loci control the production of multifoliolate leaves. The stability of expression of this trait is currently under investigation (Fox, 1991).

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