Harvest Management Effects on Yield and Quality of Small-Seeded Annual Legumes in Western Montana

Berseem clover with two cuttings yields 3-4.5 tons per acre; nitro alfalfa with three cuttings yields less but with higher protein.

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Introduction

Small-seeded annual legumes may have a place in western Montana agriculture due to the flexibility they offer in production systems. They can provide the benefits of perennial legumes in annual cropping systems and fit more easily into rotations. They also have potential for use in low-input systems where green manure may be produced for its nitrogen contribution without expending an entire growing season. The legume may be managed for one or more hay cuttings with regrowth used for green manure (4). 'Nitro' alfalfa was released for this specific purpose, since it fixes more nitrogen late in the growing season than previous varieties (3).

Berseem clover, a purported nonbloating legume, also may be adapted to this practice. The varieties 'Bigbee,' developed for its cold hardiness, and 'Multicut,' developed for its regrowth characteristics, are grown as forages in the southern U.S. (2) but have only been tested to a limited extent in the Northern Great Plains and Pacific Northwest. If these species are to play a role in Montana agriculture, we need to determine optimum management systems for their production. Two experiments were conducted to evaluate the effects of cutting schedules on the yield and quality of selected small-seeded annual legumes in western Montana. The first determined harvest management effects on forage production and protein levels of Nitro alfalfa and Bigbee berseem clover at Montana State University's Western and Northwestern Agricultural Research Centers. The second compared these two legumes to 'Vancor' alfalfa and 'Maral' Shaftal clover.

Materials and Methods

Experiment 1. Experiments were conducted on a loam soil at the MSU Western Agricultural Research Center near Corvallis, and on a silt loam at the MSU Northwestern Agricultural Research Center near Kalispell. Main plots consisted of Bigbee berseem clover and Nitro alfalfa arranged

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in a randomized complete block design with four replications.

Seed was inoculated with *Rhizobia sp* specific to each legume and drilled at a rate of 10 lb/acre on May 2, 1988 at Western and May 3 at Northwestern. Row spacing was 12 inches. The crop was managed similar to a first-year seeding of perennial alfalfa under sprinkler irrigation. Total water (precipitation + irrigation) was 23.2 and 21.9 inches for Western and Northwestern, respectively. EPTC was preplant incorporated at a rate of 3 lb AI/acre at each location. Phosphorous fertilizer (0-45-0) was applied preplant at a rate of 50 lb P_2O_5/acre at Northwestern and 60 lb P_2O_5/acre at Western.

Treatments within the main plots were four harvest managements (Table 1). Subplots were harvested at the prescribed times with small-plot forage harvesters, the fresh weights were determined from the entire sample, and a subsample was taken for dry weight and quality analysis. Protein content was calculated based on total Kjeldahl nitrogen.

Table 1.
Cutting schedules for four harvest management treatments applied to Bigbee berseem clover and Nitro alfalfa at the MSU Western (W) and MSU Northwestern (NW) Agricultural Research Centers in 1988

No. of Harvests	Location	First Harvest	Second Harvest	Third Harvest	Final Harvest
			Harvest Date		
One	WARC				Oct 27
	NWARC				Oct 15
Two	WARC	July 11			Oct 27
	NWARC	July 11			Oct 15
Three	WARC	July 11	Aug 25		Oct 27
	NWARC	July 11	Aug 26		Oct 15
Four	WARC	July 11	Aug 11	Sept 13	Oct 27
	NWARC	July 11	Aug 11	Sept 11	Oct 15

Table 2.
Cutting schedule for the three harvest management treatments applies to Bigbee berseem clover, Nitro and Vancor alfalfa, and Maral Shaftal clover at the MSU Western Agricultural Research Center in 1988.

No. of Harvests	First Harvest	Second Harvest	Third Harvest	Final Harvest
		Harvest Date		
Two	July 26			Oct 27
Three	July 20	Sept 1		Oct 27
Four	July 11	Aug 11	Sept 13	Oct 27

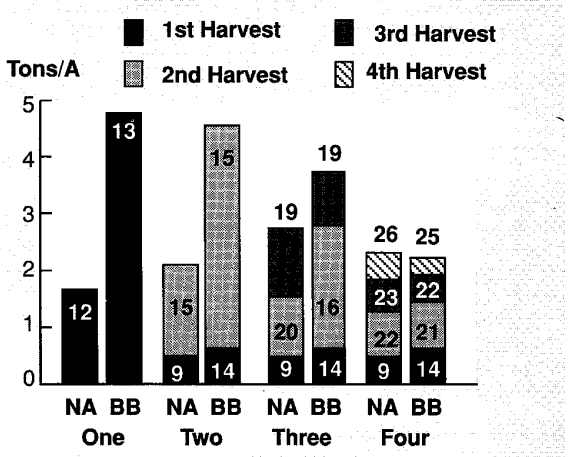
Experiment 2. Main plots were three harvest management treatments (Table 2) and subplots were four species or varieties of legumes consisting of Bigbee berseem clover, Nitro alfalfa, Vancor alfalfa, and Maral Shaftal clover. The trial was planted on May 13, 1988 at Western and managed similar to Experiment 1 except that no herbicide was applied. Weed control was by hand. Yield and protein determination were the same as Experiment 1.

Results and Discussion

Experiment 1. Bigbee berseem clover yields were highest with the one or two harvest managements (4.5 T/acre) and declined with increasing harvest frequency at Western (Figure 1). Nitro alfalfa, however, increased in yield with increasing harvest frequency up to three harvests (3 T/ac) and then declined slightly with four harvests. The considerable yield difference between the two species with the single harvest system diminished with harvest frequency; yields were virtually identical with the four-cut system.

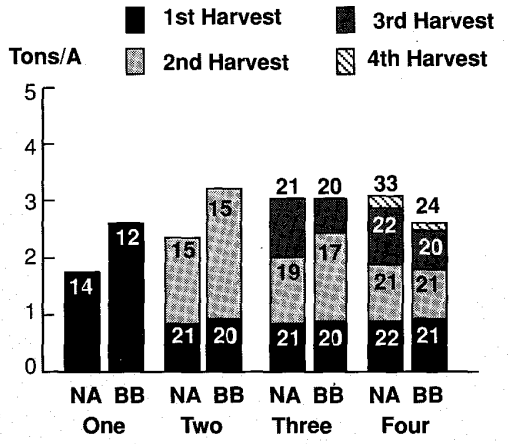
Nitro forage yields followed the same trend at Northwestern (Figure 2), although they did not

Figure 1:
Forage Yield and Protein of Two Legumes Under Different Harvest Systems at MSU's Western Research Center at Corvallis



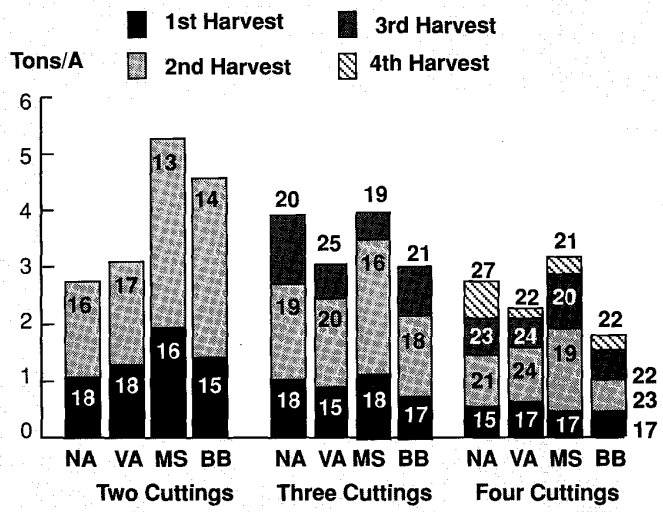
NA = Nitro Alfalfa BB = Bigbee Berseem Clover
Figures within or over bars represent protein percentages for individual harvests. An LSD 0.05 value of 0.92 Tons per acre can be used to compare species within a single harvest management system or to compare harvest management systems within a species.

Figure 2:
Forage Yield and Protein of Two Legumes Under Different Harvest Systems at MSU's Northwestern Research Center at Kalispell



NA = Nitro Alfalfa BB = Bigbee Berseem Clover
Figures within or over bars represent protein percentages for individual harvests. An LSD 0.05 value of 0.35 Tons per acre can be used to compare species within a single harvest management system or to compare harvest management systems within a species.

Figure 3:
Forage Yield and Protein of Four Legumes Under Different Harvest Systems at MSU's Western Research Center at Corvallis



NA = Nitro Alfalfa; BB = Bigbee Berseem Clover; Vancor Alfalfa = VA; Maral Shaftal Clover = MS
Figures within or over bars represent protein percentages for individual harvests. An LSD 0.05 value of 0.75 Tons per acre can be used to compare species within a single harvest management system or to compare harvest management systems within a species.

decrease as harvest frequency increased from three to four. At Northwestern, Bigbee did not achieve the high yield levels in the one-harvest system as at Western. In fact, yields of Bigbee were highest with two or three harvests at this site. The difference in yields between species followed the same pattern as at Western. Bigbee had higher yields than Nitro alfalfa with the less frequent harvests but these differences disappeared or reversed with more frequent harvests.

Differential species response to harvest management most likely reflects differences in growth habit. Perennial species such as alfalfa must store carbohydrates in their root systems to ensure winter survival. To achieve this, preferential allocation of photosynthates switches from top growth to root storage following the flowering period. Although Nitro alfalfa is called an annual, it is actually a nondormant perennial that usually winter kills in northern climates. However, re–growth in the spring following this experiment demonstrated that Nitro was capable of surviving the most severe cold spell on record at Western (-30° F on February 4, 1989; snow cover was approximately one inch). Winter survival was observed to decline with increasing harvest frequency, indicating greater root storage of carbohydrates with less frequent harvests. The truly annual habit of Bigbee berseem clover forgoes root storage in favor of top growth and thus it does not slow growth to as great a degree following flowering.

Protein concentrations of both species increased significantly with increasing cutting frequency (Figures 1 & 2), reflecting the harvest of younger plant material. Nitro had equal or higher protein levels than Bigbee across all management systems at Northwestern but only for the three and four-harvest systems at Western. An optimum balance between forage production and protein content was achieved with three cuts for both species at both locations. The high level of forage production by berseem clover with the one or two-harvest systems was at the expense of forage quality and did not result in higher total protein production (forage yield x protein content) than the three-cut system.

There was no consistent difference between species for total protein production, except that Nitro produced more protein than Bigbee in the last one or two cuttings of the three or four-cut systems. Nitro was selected for its greater capability for late-season dry matter production and

nitrogen fixation compared to other alfalfa varieties (3); apparently, it holds an advantage in these characteristics when compared to berseem clover as well.

Experiment 2. When harvested twice during the growing season, forage yields of 4.5 to 5.5 T/acre were obtained from Maral Shaftal and Bigbee berseem clovers compared to about 3 T/acre from the two alfalfa varieties (Figure 3). As in Experiment 1, this reflects the differential growth and root storage response of annuals and perennials to flowering.

Increasing frequency of harvests had markedly different effects on the various species and varieties. Total yields of Maral Shaftal and Bigbee berseem clovers declined significantly with successive increases in harvest frequency. Nitro alfalfa, however, produced more (4 T/acre) with the three-harvest system than with the two-harvest system (2.5 T/acre). Yields of Vancor alfalfa were the same with either the two or three-harvest systems but, as with the other legumes, were significantly lower with the four-harvest system.

Nitro alfalfa had the highest yields on the final cut in the three and four-cut systems. The difference between Nitro and Vancor alfalfas in late-season growth reflects the non-dormant characteristic of Nitro compared to the dormant characteristic of Vancor. In the two-harvest system, Nitro had the same late-season growth as the other legumes, highlighting the importance of managing this alfalfa variety properly for maximum benefits in rotations with other crops. Nitro yields from the first two harvests in the three-harvest system were as high as total yields in the two-harvest system.

As in Experiment 1, protein content significantly increased with increasing cutting frequency (Fig. 3). The two alfalfa varieties consistently had higher protein contents than either clover species across all management treatments. Maral Shaftal clover was consistently lower in protein content than all other legumes, which was expected based on the high level of dry matter production. An optimum balance between forage production and protein content appears to be reached with the three-harvest system, supporting the results in Experiment 1.

Conclusions

Harvest management decisions must be based on the species grown and desired forage quality. If the producer desires a relatively low protein content in the range of 15 percent as may be appropriate for certain beef cattle or other livestock, then Bigbee berseem clover in a two-harvest system will produce 3 to 4.5 T/acre of dry forage, consistently higher yields than can be attained with Nitro alfalfa. If, however, a No. 1 hay quality is desired, then the minimum protein level is 19 percent (1). Nitro alfalfa in the three-harvest system will yield 3 to 4 T/acre at this quality level. Bigbee in the three-harvest system will yield similarly, but the second cutting (where most of the yield is attained) will only have 16 to 18 percent protein. Only in a four-harvest system will Bigbee consistently have protein levels above 19 percent but at a reduced yield level compared to Nitro in the three-harvest system.

If even higher protein levels are desired, then Nitro can be harvested four times to yield two to 3 T/acre with protein levels over 20 percent. Bigbee will not hold up as consistently in yield and quality under this harvest management system.
Nitro alfalfa produced more dry matter and total protein than a first-year stand of Vancor alfalfa, a dormant variety. This was due to the late-season growth characteristics of Nitro, making it the better choice for use as an annual.

Maral Shaftal clover is a promising small-seeded annual forage demonstrating a high yield potential although protein quality is slightly lower than for Bigbee under similar management systems.

Acknowledgments

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