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for silage in Idaho

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Contents

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Summary

Four years of agronomic testing have shown that sunflowers can produce good silage yields in dryland cool-season areas with approximately 23 inches of precipitation. Variety maturity at time of cutting will have a large influence on yield and chemical composition of silage. For maximum vegetative yield and lower levels of fiber, growers should plant a late season variety in cool season areas. Harvest date then can be delayed until 58 percent of the head has immature seed. If higher fat and protein values are desired, an early season variety can be planted. Choosing a short season variety with a high proportion of head to stem weight would also increase fat levels.

Silage yield and chemical composition were not affected by seed size. Growers should plant the smaller, less expensive size 4 or 5 seed. Smaller seed sizes are also more compatible with drills than the larger seed sizes.

Nitrogen requirements for optimum sunflower silage yields in northern Idaho is about 100 pounds per acre. If residual soil nitrogen and nitrogen expected from mineralization totals 100 pounds per acre, no nitrogen fertilizer would be needed. Nitrogen fertilizer had a relatively small effect on fiber and fat values but can improve protein level of the silage. Excess nitrogen can lower yields by increasing the opportunity for Sclerotinia white mold infection.

Under irrigation in southern Idaho, sunflowers did not produce as much forage as corn or sudangrass. Sunflowers planted in mid-May produced twice as much forage as sunflowers planted in mid-July when both planting dates were harvested in early September. Sunflowers did not appear to be an acceptable alternative to corn or sudangrass as a second crop in a double cropping system in southern Idaho.

Feeding trials indicate that sunflower silage is an acceptable forage for growing beef steers, dairy heifers and dairy cows in mid- to late-lactation. The high moisture content of sunflower silage may be a problem; however, the dry matter content of the silage may be increased by ensiling the sunflower forage with a drier forage and/or cereal grain.

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Sunflowers for Silage in Idaho

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Introduction

The success of sunflower as a silage crop has varied with variety, location, management and class of livestock fed the silage. Results from early studies showed that sunflower silage had only 60 to 80 percent of the feed value of corn silage (1, 5, 7).[1] However, most of this early work was conducted on varieties with smaller heads and more stem material than current oil seed varieties. Recent work in northern Idaho has shown that variety choice can have a large impact on silage yield but has had a small impact on quality. In these studies, the best varieties produced 25 percent more yield than the worst.

Planting dates, harvest dates and fertility practices have also influenced yield and nutritional value of sunflower silage in northern Idaho and other locations (17). Delayed planting in the spring, early harvest and low rates of nitrogen when residual soil levels were low were generally associated with low silage yields.

The feeding and nutritional value of sunflower silage is further complicated by type of livestock using the silage (6, 13, 14, 15, 16). Sunflower silage was generally found to be an accepted forage for growing beef steers, dairy heifers and dairy cows in mid- to late-lactation.

Sunflower silage yields have been superior to corn silage yields in dryland areas having short, cool growing seasons (8). Sunflowers may also have some potential as a second silage crop in warm season irrigated areas (12).

This publication summarizes 4 years of agronomic testing and feeding trials conducted by the University of Idaho. Recommended production practices from research by other scientists at other locations are also included.

[1]Numbers in parenthesis refer to articles listed in reference section.

General Production Requirements

Seeding Operations

Seedbed Preparation

Conventional, minimum and no tillage systems have been successfully used for sunflower production (10). Successful systems result in (a) placement of the seed in firm but uncompacted soil with moisture adequate for germination, (b) weed control at planting and emergence by proper use of registered herbicides and/or cultivation, (c) crop residue levels that do not interfere with cultivation, irrigation, herbicide or fertilizer operations and (d) reduced soil erosion.

Sunflowers grown under furrow irrigation are usually planted on raised beds. Seed planted on beds are exposed to warmer temperatures, less flooding and usually have better seedling emergence than seed planted on level soil. However, more lodging was observed on sunflowers planted on raised beds than sunflowers planted on level ground. Hilling can reduce lodging.

Planting Equipment

Conventional plate planters commonly used for corn, beans or sugarbeets can be used for planting sunflowers. Plates with hole size to match seed size are necessary for good stands. Nylon or plastic brushes instead of metal brushes should be used to push seeds into holes on the plates to reduce mechanical damage to the seed.

Kirschmann (Melroe) grain drills have been successfully used for solid seeding in 12-inch row spacings (3). However, accurate seed spacing within the row is usually a problem with most conventional grain drills.

Fig. 1. Uniform plant stands with 20,000 to 25,000 plants per acre are necessary for optimum yields.

Fig. 2. Row spacing should match harvest equipment to prevent separate cutting and harvest operations as shown here.

Planting Dates and Depths

Sunflowers should be planted when temperatures are 45 to 50°F in the top 3 inches of soil but no sooner than 2 weeks before the last killing frost (10). These conditions usually occur shortly after seeding of spring cereals. Sunflowers in the early seedling stage are tolerant to frosts with temperatures down to 26°F, but sunflowers lose most of their frost tolerance by the six-leaf stage. Extremely early seeding in North Dakota was not found to be advantageous over recommended conventional times (11). Slower germination, reduced vigor, increased stem weevil, head moth, downy mildew and increased potential for frost damage were found to be potential problems from early seeding.

Planting depths should be 1 to 1½ inches (10). Seed can be planted at a maximum depth of 3 to 4 inches to reach moisture, but emergence will be delayed compared to shallower seed placement in moisture. Deeper seeding may be needed in sandy soils because of moisture limitations near the surface. Crusting after deep planting is particularly detrimental to plant emergence.

Plant Populations

Optimum populations for silage will vary with variety, location and precipitation or irrigation (17). Large variations in plant populations will permit optimum silage yields (10). Thin stands have greater weed and insect problems, while dense stands are more susceptible to Sclerotinia white mold and lodging. Populations of 20,000 to 25,000 plants per acre are recommended for silage production in dryland areas of northern Idaho with 19 to 23 inches of precipitation and in northern and southern Idaho irrigated areas (Fig. 1) (9).

Row Spacing

Row spacing should match silage harvest equipment (Fig. 2). Row spacings vary between 22 and 38 inches in most production areas where other row crops are commonly produced (10). Narrower row spacing (12 inches) will hasten maturity in cool season areas and when used as a second crop in a double cropping sequence. Cultivation won't be possible when row spacings are 12 inches or less. Excellent weed control by pre-plant cultivation and herbicide use is required when row spacings of 12 inches or less are used (13).

Northern Idaho Studies

Seed Size

Seed size did not affect sunflower silage yields in either 1978 or in 1979 in northern Idaho (Table 1) (2). Sunflowers averaged 15.8 and 7.3 tons per acre of silage in 1978 and 1979, respectively. In the 1979 trial, the plants had limited moisture during July and August which reduced silage yield. Chemical analyses of the dried silage from the 1979 trial indicated that seed size did not effect silage quality. It appears that sunflower silage fields could be planted with the smaller, less expensive size 4 and 5 seed without detracting from either silage yield or quality.

Variety Performance

Table 2 shows that sunflowers variety trials in northern Idaho yielded an average of 14.1, 10.6 and 11.4

Table 1. Silage yields and chemical composition of dried silage grown from four seed sizes of sunflower hybrids SIGCO 894 and SIGCO 903 grown under dryland conditions at Moscow, Idaho, in 1978 and 1979.

	Silage yields[1]		Chemical composition of 1979 silage				
Seed size	**1978**	**1979**	**Protein**	**Hemicellulose**	**Cellulose**	**Fats**	**Lignin**
	(tons/acre)		(%)				
2	14.9	7.6	7.8	3.3	29.0b*	13.7	7.4
3	15.5	7.4	7.9	2.8	30.5a	14.5	7.7
4	16.9	7.3	7.7	3.0	29.2b	12.7	7.4
5	15.7	6.8	8.2	2.6	29.9ab	12.8	7.6
	NS	NS	NS	NS		NS	NS

[1] Adjusted to 70 percent moisture.

*Mean values within a column not followed by the same letter differ at the 0.05 level of probability according to Duncan's multiple range test. NS — means not significantly different.

Trials were maintained at population of 25,000 plants per acre. Both trials were fertilized with 100 pounds N. The 1978 trial was planted on May 4 and harvested on September 9. The 1979 trial was planted on April 21 and harvested on August 24.

Table 2. Silage yield and chemical analysis of sunflower varieties evaluated under dryland conditions at Moscow, Idaho, in 1978, 1979 and 1980.

		Chemical composition of dried silage				
Variety	**Silage[1] yield**	**Protein**	**Hemi-cellulose**	**Cellulose**	**Fats**	**Lignin**
	(tons/acre)	(%)				
1978 Trial						
Master X	13.0a*	12.7a*	2.4a*	31.4ab*	10.1ab*	7.7a*
POI 3F	12.4a	12.5a	3.3a	32.8ab	10.6a	8.0a
Peredovik	14.6a	12.0a	4.0a	33.3a	9.1ab	8.0a
SIGCO 894	14.8a	12.0a	3.1a	30.7b	6.4c	7.8a
POI 1F	15.3a	11.8a	4.1a	32.3ab	8.6b	7.6a
POI 6F	13.7a	11.4a	3.8a	32.6ab	6.9c	8.1a
Sun Hi S301A	16.6a	11.2a	2.6a	31.0ab	6.5c	7.9a
POI 5F	12.6a	10.8a	3.9a	30.5b	5.0c	8.1a
1979 Trial						
Sun Gro S380A	11.7a*	11.7ab*	2.9ab*	29.2c*	4.2d*	6.8b*
SIGCO 449	11.1a	12.2ab	3.7a	31.8a	7.3b	7.6a
Sun Hi S304A	11.2a	11.4b	3.3ab	31.0ab	5.2cd	6.9b
Sun Hi S108	8.8a	12.9a	2.0b	32.4a	8.9a	7.6a
Sun Hi S301A	10.3a	12.6a	3.0ab	29.8bc	5.2ab	7.2cd
SIGCO 894	10.2a	12.7a	3.2ab	29.4c	6.1bc	7.2ab
IS 7775	10.6a	12.3ab	3.2ab	31.1ab	6.1bc	7.3ab
1980 Trial						
POI F801	15.1a*					
POI F805	14.1ab					
Sun Gro 380A	12.1ab					
Sun Gro 372A	12.0ab					
POI F804	11.9ab					
POI F803	11.9ab					
Sun Hi 304A	11.5ab					
Sun Hi 301A	10.5ab					
Sun Hi 108	10.3ab					
POI F802	10.2ab					
Dahlgren 716	10.1ab					
SIGCO 449	10.1ab					
SIGCO 894	9.3b					

1978 — Trial planted May 9 and harvested August 25. Seedbed fertilized with 100 pounds N per acre.

1979 — Trial planted May 16 and harvested August 15. Seedbed fertilized with 100 pounds N per acre.

1980 — Trial planted April 23 and harvested August 14. Seedbed fertilized with 31 pounds N per acre.

All trials maintained at a plant population of 49,000 plants per acre.

[1] Adjusted to 70 percent moisture.

*Means within a column in each year not followed by the same letter differ at the 0.05 level of probability by Duncan's new multiple range test.

tons of silage per acre in 1978, 1979 and 1980, respectively. Statistical differences in silage yields among the varieties were detected only in the 1980 trial. The experimental forage hybrid, POI F801, yielded 5.8 tons more silage per acre than SIGCO 894, the most commonly grown hybrid for seed production. In all trials, the taller, later-maturing hybrids tended to produce the greatest forage yield. It appears that sunflower hybrids could be developed specifically for high forage yields. Until hybrids specifically designed for forage production are commercially available, maximum yield could probably be obtained by growing late maturing hybrids such as Sun Gro 380 A.

The protein content of the dry forage of the varieties averaged 11.8 and 12.3 percent in 1978 and 1979, respectively (Table 2). The dry silage of all varieties in both years contained about 3 percent hemicellulose, 31 percent cellulose, 7 percent lignin and 5 to 10 percent fats on a dry weight basis. Chemical composition of the silage from different varieties was nearly equal, indicating that silage quality of the varieties was nearly equal.

Harvest Dates

Tables 3 and 4 show that harvest dates that ranged from late August to mid-September had no influence on silage yield of sunflowers at either Moscow or Grangeville, Idaho. Potential silage yield (70% moisture) was 13.1 and 11.1 tons per acre at Moscow and Grangeville, respectively. In these trials, head filling was 39 and 45 percent complete on the early harvest dates at Moscow and Grangeville, respectively, and increased to about 58 percent complete by the late harvest dates. Increased head filling more than compensated for weight loss from senesced leaves but did not significantly change whole plant yield. Earlier harvest dates than those used in these trials would have been expected to reduce yield levels (4).

Nitrogen Fertilization and Yield

Nitrogen (N) fertilization increased silage yield in only one of five trials. In that trial at Grangeville, N rates of 30 and 60 pounds per acre increased silage yield 1.5 and 3.5 tons per acre (Table 4). Residual soil N level in the surface 2 feet was 27.5 pounds per acre. In other fertilization trials at Moscow and Grangeville, sunflower yield did not respond to rates of N up to 100 pounds of N per acre. Soil residual levels were 12, 43, 84 and 136 pounds per acre in these trials. Lack of yield response from applied N when soil residual N was 12 pounds per acre may have been partially caused by increased Sclerotinia white mold when high rates of N were used. High mineralization rates from previously applied manure may have also reduced responses to applied N in this trial. Apparently residual soil N levels of 43 pounds per acre and higher along with N mineralized and released during the growing season (about 60 pounds per acre) was sufficient for optimum silage yields (Fig. 3, see page 9).

From our studies, 80 to 100 pounds of available N (residual, mineralizable, plus applied) appears adequate for optimum silage yields in northern Idaho. Mineraliz-

Table 3. Influence of variety, harvest, cutting date and nitrogen fertilization on agronomic performance and chemical composition of sunflowers grown under dryland conditions at Moscow, Idaho.

	Silage[1] yield	Moisture[2]	Leaf senescence[2]	Head fill[2]	Head stem[2]	Chemical composition[2] Protein	EE	NDF	ADF
	(tons/acre)	(%)	(no.)	(%)	(ratio)	(%)			
Variety									
S-372A	14.2	75.5	15.6	44.8	0.6	6.2	5.8	43.5	31.9
D-716	12.1	71.6	15.3	61.0	1.2	7.5	8.1	49.8	36.1
LSD (0.05)*	2.2	2.8	NS	3.2	0.2	0.3	0.7	1.1	1.4
Harvest date									
August 29	13.9	75.5	11.8	44.9	0.8	6.9	5.3	43.5	32.0
September 8	12.8	74.6	15.1	57.3	0.9	6.9	7.7	47.0	33.6
September 15	12.8	70.6	19.5	56.6	1.0	6.9	7.6	49.4	36.5
LSD (0.05)*	NS	2.1	3.3	7.4	NS	NS	0.8	1.3	1.7
Nitrogen level pounds per acre									
0	13.0	74.3	14.9	57.0	1.0	5.6	6.9	46.6	34.4
50	12.8	73.2	15.7	51.7	0.9	6.2	7.0	46.6	34.1
100	13.7	73.1	15.8	50.1	0.8	8.1	6.7	46.7	33.6
LSD (0.05)*	NS	1.2	NS	NS	NS	0.4	NS	NS	NS

[1]Adjusted to 70 percent moisture.

[2]Moisture, leaf senescence, head fill, head-stem ratios and whole plant chemical composition estimated from two plant samples at harvest.

*Differences between mean values within a treatment that equal or exceed the LSD value are statistically different at the 0.05 level of probability. NS — means are not significantly different.

able N from northern Idaho soils should be 40 to 60 pounds per acre. If soil tests show 60 pounds of N per acre or more, N fertilization should not be needed for optimum yields in northern Idaho.

Nitrogen Fertilization and Chemical Composition

Nitrogen rates of 50 and 100 pounds per acre increased protein levels 2.5 percent at Moscow (Table 3) but did not influence protein level of sunflower grown at Grangeville (Table 4). Nitrogen applied at Grangeville may have been used for increased yield rather than increased protein content. In another trial (data not shown), 150 pounds of N nearly doubled protein levels (4.6 to 9.0%) compared to protein level of unfertilized sunflowers. Nitrogen rate did not influence fat (EE), neutral detergent fiber (NDF) or acid detergent fiber (ADF) levels of whole plants (Table 3). In contrast to variety choice and harvest date, manipulation of N rate would not be expected to alter EE, NDF and ADF levels of sunflower silage.

Table 4. Influence of harvest date and nitrogen fertilization on agronomic performance and nitrogen level of sunflower variety S-371A grown under dryland conditions at Grangeville, Idaho.

	Silage[1] yield	Whole plant[2] Moisture	Leaf senescence	Head fill	Head stem	Protein
	(tons/acre)	(%)	(no.)	(%)	(ratio)	(%)
Harvest date						
August 22	10.9	80.6	11.9	39.2	0.6	5.4
September 9	11.3	76.1	16.0	58.8	1.0	6.0
LSD (0.05)*	NS	1.2	1.4	13.9	0.1	0.5
Nitrogen level pounds per acre						
0	9.5	79.8	49.6	49.6	0.8	5.7
30	10.9	77.9	50.2	50.2	0.8	5.8
60	13.0	77.2	47.1	47.1	0.8	5.7
LSD (0.05)*	1.4	1.5	NS	NS	NS	NS

[1]Adjusted to 70 percent moisture.

[2]Estimated from two plant samples at harvest.

*Differences between mean values within a treatment that equal or exceed the LSD value are statistically different at the 0.05 level of probability. NS — means are not significantly different.

Southern Idaho Studies

The influence of harvest dates, planting dates and variety on silage yield and chemical composition was tested under irrigation at Parma, Idaho. Varieties used were Dahlgren 704XL, Dahlgren 716, SIGCO 894 and Sun Gro 372A. Variety performance, except for fat percentage in one trial, was not significantly different, thus yield and chemical composition data presented in the following section represent an average response of the four varieties.

Harvest Dates

Table 5 shows that harvest dates of September 4 and September 18 at Parma in 1980 had little impact on silage yield when sunflowers were planted on June 11. Silage yields of sunflowers planted on July 20 increased from 4.4 to 7.6 tons per acre as the harvest date was delayed from September 4 to October 13 (Table 6). Late harvest dates will be necessary for maximum silage yields of sunflowers planted mid-July in the Treasure Valley near Boise, Idaho. As harvest date was delayed, ash, calcium and protein decreased while fats and lignin contents increased. Silage characteristics of later planted sunflowers were more affected by harvest dates than silage characteristics of earlier planted and more mature sunflowers.

Planting Dates

Planting dates of May 13, June 11 and July 20 were evaluated for their effects on silage yields in 1980 at Parma. Silage yields for the May 13 and June 11 plantings did not differ on September 4 and averaged 9.3 tons per acre (Table 7). Sunflowers from the July 20 planting yielded less than one-half those planted earlier when harvested on September 4. As planting date was delayed from May 13 to July 20, ash and protein content of sunflowers harvested on September 4 increased whereas fats, lignin, calcium and yield decreased. These data indicate the relative immaturity of later planted sunflowers harvested in early September.

Variety Performance

Silage yields and chemical composition (except for fat percentage in one trial) did not differ significantly among varieties when averaged across planting dates ranging from May 13 to July 20 or harvest dates ranging from September 4 to October 13. Fat percentage of Dahlgren 704X1 averaged 8, 69, 58 and 40 percent higher than fat percentage of Sun Gro 372A, Dahlgren 716 and SIGCO 894, respectively, when sunflowers were planted on June 11 and harvested on September 4. The higher percentage of fat in Dahlgren 704X1 was probably caused by earlier maturity of Dahlgren 704X1 compared to other varieties in this trial. Fat percentages of sunflower varieties were not different in all other planting and harvest date trials.

Double Cropping Potential

Double cropping is the production of two crops, one following the other, within the same year on the same acreage. Double cropping in the warmer areas of Idaho, primarily the Magic and Treasure Valleys near Twin Falls and Boise, respectively, has potential for significantly increasing the total annual per acre production of forages. Cool and warm season forages can be harvested before absolute maturation, therefore, forages in particular may be more appropriate commodities for successful double cropping than grain crops. Cool season forages will more efficiently use heat units in the fall and spring seasons of the year, while warm season forages will more efficiently use the warmer temperatures of summer.

Table 5. Agronomic performance and silage characteristics of sunflowers[1] planted on June 11 and July 20 and harvested on September 4 and September 18 at Parma, Idaho, in 1980 (irrigated).

Date Planted	Date Harvested	Silage[2] yield	Ash	Protein	Fat	Lignin	Cellulose	Hemi-cellulose	Ca	P
(mo/day)	(mo/day)	(tons/acre)	(% dry weight)							
June 11	Sept. 4	9.7	14.0	8.6	4.8	7.0	27.5	3.7	1.5	0.26
June 11	Sept. 18	9.0	12.0	8.6	13.1	8.4	29.1	1.8	1.5	0.27
July 20	Sept. 4	4.4	17.9	11.5	1.5	4.9	27.2	2.6	1.7	0.29
July 20	Sept. 18	5.4	14.1	11.0	2.4	5.7	27.1	3.8	1.5	0.29
ANOVA					P>F*					
Planting date		**	*	**	**	**	NS	NS	*	*
Harvest date		NS	**	NS	**	*	NS	NS	NS	NS
Planting x harvest date interaction		NS	NS	NS	**	NS	NS	**	**	NS

[1] Average of four varieties.

[2] Fresh weights, not corrected to uniform moisture.

Indicates significance for planting dates, harvest dates or interaction between planting and harvest date for each yield and chemical component (at 0.05 level; ** at 0.01 level).

Table 6. Agronomic performance and silage characteristics of sunflowers[1] planted on July 20 and harvested on September 4, 18 and October 13 at Parma, Idaho, in 1980 (irrigated).

Date harvested	Silage[2] yield	Ash	Protein	Fat	Lignin	Cellulose	Hemi-cellulose	Ca	P
(mo/day)	(tons/acre)	(% dry weight)							
Sept. 4	4.4b*	17.9a*	11.5a*	1.5b*	4.9c*	27.2a*	2.6a*	1.7a*	0.3a*
Sept. 18	5.4b	14.1b	11.0a	2.4b	5.7b	27.2a	3.8a	1.5b	0.3a
Oct. 13	7.6a	12.6b	9.7b	6.7a	6.4a	25.5a	3.6a	1.3c	0.3a

Table 7. Agronomic performance and silage characteristics of sunflowers[1] planted on May 13, June 11 and July 20 and harvested on September 4 at Parma, Idaho, in 1980 (irrigated).

Planted	Silage[2] yield	Ash	Protein	Fat	Lignin	Cellulose	Hemi-cellulose	Ca	P
(mo/day)	(tons/acre)	% of dry weight							
May 13	8.9a*	12.8b*	8.4b*	11.0a*	7.3a*	28.4a*	2.4a*	1.6b*	0.3a*
June 11	9.7a	14.0b	8.6b	4.8b	7.0a	27.5a	3.7a	1.5c	0.3a
July 20	4.4b	17.9a	11.5b	1.5c	4.9b	27.2a	2.6a	1.7a	0.3a

[1] Average of four varieties.

[2] Fresh weights, not corrected to uniform moisture.

*Means within a column followed by the same letter differ at the 0.05 level of probability according to an F test.

Fig. 3. Healthy, well-fertilized stand of sunflowers at full flowering stage of development.

Experience with sunflower silage in southern Idaho is limited to the 1980 trial at Parma. Field experiments have not been conducted to directly compare sunflower silage production with other second crop forages such as corn or sudangrass. Sunflower silage yields in 1980 of 3 to 11 tons per acre do not compare favorably with yields of short season corn silage of 10 to 28 tons per acre or sudangrass silage of 15 to 30 tons per acre measured at Parma in 1983 and 1984. Based on the limited production estimates from the 1980 trial at Parma, sunflower silage does not appear to be an acceptable alternative to short season corn hybrids or sudangrass as the second crop in irrigated southern Idaho double cropping forage systems. Planting dates earlier than mid-July will be necessary for maximum second crop sunflower silage yields.

Feeding Value

Chemical Composition

Sunflower silage was compared to alfalfa-grass silage in our feeding trials. Chemical composition of silages are reported in Table 8. Sunflower silage contained more ether extract (fat) (9.1 vs. 2.4%), lignin (10.0 vs. 8.4%) and calcium (1.6 vs. 1.2%) but less crude protein (10.2 vs. 11.8%) and fiber (38.0 vs. 48.3%) than alfalfa-grass silage. Calculated total digestible nutrient (TDN) values using the crude protein and acid detergent fiber content of the silage were 52.8 percent for alfalfa-grass silage and 50.9 percent for sunflower silage. This calculation, however, may underestimate the energy content of sunflower silage since fat content is not taken into account. Fat provides approximately 2.25 times more energy than carbohydrates and proteins, and sunflower silage contained 3.8 times more fat than alfalfa-grass silage.

Feeding Trials

Beef — Digestion and feeding trials (Fig 4) were conducted to determine the effect of level of intake and

Fig. 4. Sunflower silage was an acceptable forage for beef steers, dairy heifers and dairy cows in mid- to late-lactation.

soybean meal (SBM) supplementation on sunflower silage digestibility and the nutritional value of sunflower or alfalfa-grass silage fed to Angus steers (16) (Table 9). Level of intake (.9 and 1.7% of body weight in dry matter daily) had no significant effect on digestibility of the feed components evaluated. Crude protein digestibility and digestible energy (DE) concentration increased when sunflower silage was supplemented with SBM. The increase in DE concentration was greater than anticipated when 10.3 percent SBM containing 1.6 Mcal per pound of DE was added. Calculated DE concentration of sunflower silage with SBM was 1.1 Mcal per pound.

Steers fed sunflower silage (60% silage, 40% concentrate) gained at the same rate, 2.6 pounds per day, but consumed 7.1 percent more dry matter daily than those fed alfalfa-grass silage (Table 10). Greater dry matter (DM) intake by steers fed sunflower silage may have been caused by the higher DM and lower acid detergent fiber concentrations of the sunflower silage diet vs. the alfalfa-grass silage diet. Steers fed sunflower silage required slightly more dry feed per pound of gain than those fed alfalfa-grass silage (6.0 vs. 5.6).

Dairy Heifers — The performance of Holstein heifers fed sunflower or alfalfa-grass silage rations was investigated (14). Experimental rations contained 75 percent forage as alfalfa-grass or sunflower silage and 25 percent concentrate on a dry matter basis. Daily dry matter intake of heifers fed the alfalfa-grass silage ration was 21.3 pounds, 3.3 pounds greater than those fed the sunflower silage ration (Table 10). Heifers fed the sunflower silage ration gained 1.1 pounds per day, the same as heifers fed alfalfa-grass silage. Less dry feed per pound of gain was required for sunflower silage than alfalfa-grass silage, 20.0 vs. 21.3, respectively.

Dairy Lactation Trial — A lactation trial compared milk production of cows fed alfalfa-grass or sunflower silage rations (15). Eighteen lactating Holsteins were in a switchback design of three, 5-week periods. Experimental rations were composed of 60 percent sunflower or alfalfa-grass silage and 40 percent concentrate (barley and soybean meal) on a dry matter basis. Daily intake of dry matter from silage and concentrate as a percentage of live body weight was equal between treatment groups.

Cows fed sunflower silage consumed 12.8 pounds of neutral detergent fiber, 3.7 pounds less fiber than cows fed alfalfa-grass silage but consumed 1.8 pounds of fat, 1.1 pound more than those fed the alfalfa-grass silage rations (Table 11). Milk production averaged 38.7 pounds per day with no differences between silages. Cows fed sunflower silage produced milk with 3.2 percent fat, 0.4 percent lower than milk from cows fed alfalfa-grass silage. Lower milk fat content may have been caused by either fiber source or increased polyunsaturated fatty acid intake by cows fed sunflower silage. Milk protein levels were the same for both silages.

Table 8. Chemical composition of alfalfa-grass and sunflower silages used in feeding trials.

Silage	Total dry matter	Crude protein	Fat[1]	ADF[2]	ADL[3]	Calcium	Phosphorus
	(%)			(%)			
Alfalfa-grass	28.7	11.8	2.4	48.3	8.4	1.2	0.3
Sunflower	26.0	10.2	9.1	38.0	10.0	1.6	0.3

[1]Ether extractable.

[2]Acid detergent fiber.

[3]Acid detergent lignin.

Table 9. Dry matter intake and digestibility of sunflower silage diets fed to beef steers.

Item	CM intake	Apparent digestibility[1] OM	CP	ADF	EE	DE
	(lb per day)		(%)			(Mcal per lb)
Intake level						
Limited	4.6	52.9	63.3	31.2	83.5	1.0
Ad libitim + 10%	9.0	55.2	64.4	35.7	85.9	1.0
Supplementation						
None	7.0	51.9b*	57.0b*	32.7	87.8	1.0b*
SBM	6.8	56.2c	70.6c	34.2	81.6	1.1c

[1]OM = organic matter; CP = crude protein; ADF = acid detergent fiber; EE = ether extract; DE = digestible energy.

*Means within each column, within each treatment, not followed by the same letter differ at the .05 level of probability according to an F test. Means within each column, within each treatment, without letters are not different at the .05 level of probability according to an F test.

Table 10. Performance of beef steers[1] and dairy heifers[1] fed alfalfa-grass or sunflower silage diets.[2]

Silage	Initial weight	Final weight	Gain	Dry matter intake	Crude protein intake	Dry feed per lb gain
	(lb)		(lb per day)			(lb)
Beef steers						
Alfalfa-grass	609	764	2.6	14.5	—	5.6
Sunflower	614	773	2.6	15.6	—	6.0
Dairy heifers						
Alfalfa-grass	998	1,053	1.0	21.3a*	2.4	21.3
Sunflower	982	1,032	0.9	18.0b	2.4	20.2

[1]Angus beef steer and dairy heifer trials were conducted for 60 and 56 days, with 12 and 7 animals per treatment group, respectively.

[2]Beef steer diets were 60 percent silage, 40 percent concentrate; dairy heifer diets were 75 percent silage, 25 percent concentrate.

*Means within an animal group and in the same column not followed by the same letter differ at the .05 level of probability according to an F test. Means within an animal group in the same column without letters are not different at the .05 level according to an F test.

Table 11. Comparison of alfalfa-grass silage and sunflower silage rations on feed and nutrient uptake, milk composition and milk production of dairy cows in mid- to late-lactation.

Silage	Dry matter intake	Concen-trate mixture	Nutrient uptake[1]				Milk		
			protein	NDF	ADF	fat	production	fat	protein
	(lb per day)							(%)	(%)
Alfalfa-grass	18.5	12.3	4.2	16.5a	12.1	0.7a	38.5	3.6a*	3.0
Sunflower	18.3	12.1	4.2	12.8b	11.7	1.8b	38.9	3.2b	2.9

[1]NDF = neutral detergent fiber; ADF = acid detergent fiber; fat = ether extractable.

*Means within a column followed by the same letter differ at the .05 level of probability according to an F test. Means within a column not followed by letters are not different at the .05 level of probability according to an F test.

Recommendations

Sunflowers are not recommended for silage production in southern Idaho. Sunflowers can be used as an annual silage crop in northern Idaho areas with climates similar to those at Moscow and Grangeville, Idaho.

Specific recommendations for northern Idaho include:

1. Field selection: Well-drained, southern exposure if possible.
2. Variety selection: Late season variety for maximum yield, low fiber and low fat level. Early season variety for lower yield, higher fiber and higher fat level.
3. Seed size: 4 or 5.
4. Row spacing: 12 to 36 inches. Must match harvest equipment.
5. Plant population: 20,000 to 25,000 plants per acre.
6. Planting depth: 1 to 1½ inches.
7. Planting date: Soil temperatures 45 to 50°F. Want emergence after probability of killing frost.
8. Nitrogen: 100 pounds per acre (includes residual soil N, mineralizable N and applied N).
9. Harvest stage: 60 percent immature seed in head.
10. Silage: Wilt or add grain to increase dry matter percentage.

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