Soybean and Small Grains

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Soybean As An Alternative Forage Crop

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Soybean is presently grown almost entirely as an oil-seed crop, but was previously a popular summer annual forage legume. Perennial species, such as alfalfa and clover have now largely replaced soybean for forage production. Soybean may still be considered a viable alternative forage especially in two situations: 1) when alfalfa or clover are in short supply due to winter-killing or drought conditions or 2) when an early-killing frost terminates soybean growth prior to normal grain maturity. Because forage production represents less than 3 of the total soybean acreage in the U.S., only a limited amount of research has been conducted to determine the effects of management practices on the yield and quality of soybean forage.

Soybean forage yields and quality were obtained in a two-year study conducted in 1987 and 1989 at the University of Wisconsin. The effect of soybean variety, harvest maturity, row spacing and seeding rate on yield, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), and ether extract (EE) concentrations of the whole plant forage were determined and are shown in Table 1. We found that soybean produces reasonable yields of forage that are comparable in quality to alfalfa harvested in the first-flower stage. Maximum dry matter yields of soybean harvested for forage was 4.1 tons/acre compared to 2.7 tons/acre for seeding year alfalfa and 4.5 ton/acre for second year alfalfa harvested from adjacent fields.

Harvest Maturity

Harvest maturity had a greater effect on the yield and quality of forage produced than any of the other factors evaluated (Table 1). Soybeans were harvested at four growth stages starting at initial flowering (R_1) and ending just prior to maturity when the pods had reached maximum weight and the leaves had turned yellow (R_7), Table 2. A brief description of the harvest growth stages is presented in Table 1.

The results show that dry matter yields increase linearly with advancing maturity at harvest, from 1.1 ton/acre at R_1 to 3.3 ton/acre at R_7 when averaged across varieties, row spacings and plant density. However, quality parameters showed a curvilinear change in that crude protein concentrations declined from 20.1% at R_1 to 18.1% at R_3 but then increased to 19.2% at R_7. Other research conducted in Missouri also found a curvilinear change in soybean forage quality with advancing maturity. This is attributed to improvements in forage quality due to increased seed weight off-setting the decline in forage quality of stems and leaves.

Based on these and other studies we recommend that soybean forage be harvested between stages R_6 and R_7. At this stage, seeds completely fill the pods and the lower leaves of the plant are just beginning to turn yellow. At this time the plant has achieved it's maximum dry matter yield and is just beginning to decrease in moisture content. Although the R_7 harvest provided the greatest dry matter yields of the four harvest stages evaluated in this study, some leaf senescence had occurred. Therefore yields were slightly lower than if the plants had been harvested slightly earlier. After R_7, leaves senescence rapidly and dry matter yields start decreasing. Thus, harvest of soybean for forage should be completed no later than the R_7 stage of maturity. Harvesting soybean forage during early

reproductive development (R_1-R_5) can produce high quality forage but dry matter yields are often less than 1/3 the yield when harvested at R_6-R_7. Unless forage is in very short supply, we do not recommend harvesting at these earlier maturity stages.

Variety Selection

Soybean variety also had a significant effect on dry matter yield and forage quality. Soybean varieties have not been developed specifically for forage purposes. We compared three varieties 'Corsoy 79' an early Group II variety adapted for grain production in southern Wisconsin, 'Pella' and 'Williams 82' mid and late Group III varieties which would be considered late and very-late maturity varieties, respectively for Wisconsin. Pella and Williams 82 would not normally be planted for grain production in Wisconsin.

Differences among varieties for yield and forage quality were related to differences in relative maturity. When harvested at the R_7 stage, Corsoy 79, the earliest maturity variety averaged 3.0 ton/acre which was 0.6 ton/acre less than Williams 82 the latest maturing variety. The forage produced by Williams 82 was significantly lower in CP and EE concentrations and higher in NDF, ADF, and ADL than Corsoy 79. Pella was intermediate in dry matter yield and CP to the other two varieties.

The large increase in forage yield and the small effect on forage quality of late maturing varieties suggests that the best varieties for forage production are those that are 10-15 days later than would normally be planted for grain production. The specific variety choice will also be influenced by planting date, geographical region, and anticipated harvest time. Varieties should be planted that will reach the R_7 growth stage before the anticipated first killing frost.

Row Spacing and Seeding Rate

Soybeans planted in narrow row spacings (7 in.) produced 0.5 ton/acre or 17 more forage than when planted in wide rows (30 in.). Table 1. This advantage for narrow row spacings is nearly identical to that found for grain production (16-18) in Wisconsin and other areas of the Upper Midwest. There was little effect of row spacing or plant density on the quality of soybean forage, nor did plant density influence dry matter yield. Optimum soybean seeding rates will likely be influenced more by seed quality and the ability to provide competition with weeds than by forage yield or quality. Thus, the recommended seeding rates for soybean planted for forage are similar to those recommended for grain production and are shown in Table 3. In this study, the highest dry matter yields of 4.1 tons/acre were obtained with a combination of the late-maturing variety grown in narrow rows at the low seeding rate and harvested at R_7.

Weed Control

While not a part of this study, producers should be aware that the selection of herbicides labeled for soybean harvested for forage is more limited than for grain. Growers should carefully check the label for restrictions before applications are made. A listing of some of the herbicides that are labeled for use on soybean and their use instructions are presented in Table 4. Other methods of weed control including timely rotary hoeing and cultivation may also be useful on soybean grown for forage.

Harvesting

Soybean forage can be harvested as either silage or hay. Harvesting as hay requires much longer field drying times, increases shattering losses and can produce a very dusty hay. If harvested as a silage it is advisable to allow the forage to wilt to approximately 50% moisture before ensiling

alone, or to mix the direct cut soybean forage with corn forage before ensiling. In this study soybean direct cut at $R_1$to R_5 had approximately 80% moisture, and at R/ it was 66 moisture (Table 1). In most parts of the Upper Midwest, the harvest of soybean forage and corn silage may be timed to coincide. Research conducted at Ohio State indicates mixing 1/3 soybean forage and 2/3 corn silage permitted good storage and significantly improved the corn silage quality. Splitting fields with corn and soybean may allow a grower to harvest corn in one direction and soybean on the return pass, thus producing a mixed load which is further mixed while unloading into the silo.

Feeding

Soybean forage harvested at R_7 was comparable in CP, NDF, ADF, and ADL to alfalfa hay harvested at an early bloom stage of development, and has potential as a high-quality alternative forage. Soybean does contain much higher EE (oil) concentrations in that alfalfa is only 0.2% compared to 7-12% found in whole plant soybean forage harvested at R7. The large EE fraction is expected in soybean because seeds have a high oil concentration and comprise a large portion of the total plant dry matter at late stages of development. While the additional energy contained in the EE fraction can increase milk production it can also decrease intake and reduce fiber digestion if the EE is too high. To avoid negative impacts of feeding high levels of EE, it is recommended that the dietary EE concentration for lactating dairy cattle not exceed 5% of the total ration dry matter. Given the EE concentrations found in this study, soybean forage harvested at R_7 should be limited to no more than 50% of the total ration dry matter.

Other Advantages

In addition to the yields and quality of the forage produced, soybean offers several other advantages for use as an alternative or emergency forage. First, the equipment, seed, and technology required to grow soybeans is widely available and may already be present on the farm where it is needed. Second, if it is determined that the soybean forage is not needed, the crop can be allowed to mature and be harvested as a seed crop. This possibility should be considered before selecting an extremely late maturing variety for use as a forage. A third consideration is that soybeans can be planted fairly late in the spring, allowing a producer to access winter damage to a perennial legume stand before deciding whether or not an emergency forage crop is needed. Also, soybean forage is harvested only once during the growing season, thus reducing fuel, labor, and machinery costs compared to other forages that may be harvested three, four or five times per year. Finally, as with all legumes, soybean may provide nitrogen for the following seasons crop, although it will be less than when the crop residue is returned to the soil as with grain production.

Periods of forage shortage may not be the only time that a producer should consider harvesting a soybean field as a forage crop. If a soybean field is damaged so that it is unsuitable or unprofitable to harvest as a seed crop (such as following a hail storm or an early frost) harvesting the field as a forage may be the only economic alternative (providing that herbicide residues will not be a problem). If seed set is reduced by these conditions, the quality of forage harvested will be somewhat lower than normal because the soybean seed contributes greatly to forage quality at the later stages of maturity.

Soybean forage production can also be integrated in a double-cropping system. Research at the University of Wisconsin has shown that soybeans planted after harvesting an oat crop as silage in early July can produce from 1 to 2 tons of high-quality forage per acre. Because soybeans can be planted relatively late in the spring, it would also be possible to harvest a crop from a severely winter-damaged alfalfa stand in late May, work the field and then plant soybeans.

While not as productive as some of the perennial forage legumes, the soybean does offer some advantages that may make it a desirable alternative forage crop under certain conditions. For a producer in need of high- quality forage, soybean may be the answer.

Table 1. Yield and quality of soybean forage as affected by harvest maturity, variety, row spacing, and planting rate. Arlington, WI 1987 and 1989.

Management		Dry Matter		Crude				
Factor	Level	Yield	%	Protein	NDF[1/]	ADF[1/]	ADL[1/]	EE[1/]
		(T/A)		----------%----------				
Maturity[2/]	R1	1.1	18.9	20.1	38.7	28.2	5.9	---
	R3	1.7	19.3	18.1	43.1	31.9	6.6	---
	R5	2.5	20.3	18.2	45.7	33.7	7.1	.9
	R7	3.3	34.2	19.2	40.7	29.3	6.2	10.5
	LSD	.1		.5	.6	.5	.2	.6
Variety[3/]	Corsoy 79	3.0		20.5	40.5	28.7	6.0	11.8
	Pella	3.3		19.0	39.5	28.5	5.9	12.6
	Williams 82	3.6		18.2	42.2	30.6	6.5	7.1
	LSD	.3		.9	.1	.1	.4	.7
Row Spacing [3/]	7	3.6		18.8	40.9	28.7	6.0	11.8
(in.)	30	3.1		19.6	40.5	29.0	6.1	10.9
	LSD	.3		.6	NS	NS	NS	NS
Density[3/]	100,000	3.4		19.2	40.4	29.0	6.0	11.1
(plt/a)	300,000	3.3		19.2	41.1	29.6	6.3	9.9
	LSD	NS		NS	NS	NS	.3	.6

[1/] NDF = neutral detergent diber, ADF = acid detergent fiber, ADL = acid detergent lignin, EE ether extract.
[2/] Maturity descriptions are as follows:
R1 One open flower on the main stem.
R2 One pod 3.16 inch long at one of the four top nodes.
R5 A seed 1.8 inch long in a pod at one of the top four nodes.
R7 One pod on the main stem that has reached its mature color.
[3/] Variety, row spacing and plant density data are presented only for the R7 harvest maturity.

Table 2. Average harvest dates for soybeans grown for forage at Arlington, WI 1987 and 1989.[1/]

	Harvest Date		
Maturity	Corsoy 79	Pella	Williams 82
R1	July 13	July 18	July 26
R3	July 28	Aug.1	Aug.6
R5	Aug. 15	Aug. 17	Aug. 25
R7	Sept. 18	Sept. 27	Sept. 29

[1/] Planting was June 5, 1987 and May 16, 1989.

Table 3. Recommended seeding rates for soybean planted for forage or grain production using conventional tillage.[1/]

Row Spacing	Viable Seeds per		Seed Required
In.	Ft. of row	Acre x 1000	Lb/acre[2/]
6	3.3	200	90
10	3.4	180	80
14	4.6	170	75
18	5.5	160	70
22	6.3	150	67
30	8.0	140	62
36	9.2	133	59
40	9.9	130	58

[1/]Increase seeding rates by 20% if planting with no-till
[2/]Assumes 2500 seeds/lb and 90% germination.

Table 4. Herbicides and application methods labeled for use on soybeans harvested as a forage crop.

Pre-Plant Incorporated or Preemergence		Postmergence	
Cannon	Yes	Assure	No
Canopy	No	Basagran	Yes
Command	No	Blazer	No
Dual	Yes	Classic	No
Freedom	Yes	Fusillade	No
Gemini	No	Galaxy	No
Lasso	Yes	Lasso	No
Lexone	Yes[a]	Option	No
Lorow	Yes	Poast	Yes[b]
Lorox Plus	No	Poast Plus	Yes[b]
Preview	No	Pursuit	No
Prowl	Yes	Reflex	No
Pursuit	No	Rescue	No
Pursuit Plus	No	Storm	No
Salute	Yes[a]	Tornado	No
Sencor	Yes[a]		
Sonalan	No		
Treflan	Yes		
Turbo	Yes[a]		

[a] Allow 40 days after application before grazing or feeding.
[b] Do not graze or feed green chop or silage; treated soybean can be harvested as dry as hay and fed to livestock.

Information presented in this table reflect the label use restrictions at the time that this article was written. Be sure and check label use restrictions before selecting a herbicide to use or before harvesting soybean forage that has been treated with a herbicide.