Seeding Rate, Seeding-Year Harvest, and Cultivar Effects on Sweetclover Productivity

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The value of including sweetclover in cropping systems in the Red River Valley of North Dakota has been demonstrated. Sweetclover is known to be an excellent fixer of air nitrogen and had the greatest soil nitrate-nitrogen in the spring following five legumes. In addition, seed cost of sweetclover is less expensive than other legumes like hairy vetch and field pea, which have shown promise in cropping sequences.

Sweetclover use as a green manure crop on set-aside acreage often requires establishment without a companion crop. Recommendations on seeding rate, establishment method, seeding-year harvest, and cultivars have generally been based on results of experiments established with companion crops, so the objective of this series of experiments was to evaluate sweetclover management recommendations for clear-seeded stands.

A source of common yellow-flowered sweetclover seed was obtained from southwestern North Dakota for use in Experiment 1. Paired seed lots, one dehulled and cleaned while the other was in the seed pod, were tested for germination by standard blotter-paper technique. Cleaned, dehulled, lightly scarified seed had a germination rate of 96 percent, the other lot had a 28 percent germination rate and 70 percent hard seed. Both seed lots were inoculated with *rhizobium* bacteria and seeded broadcast at Fargo at eight seeding rates (2, 4, 6, 8, 10, 12, 16, and 20 pounds per acre of pure live seed considering hard seed as live seed). The soil is a Fargo clay testing high to very high in phosphorus and potassium, so no fertilization was required. Len wheat was seeded at 70 pounds per acre across two replicates; two replicates were rolled with a brillion seeder to incorporate the seed and firm the seedbed. Excellent weed control in the clear-seeded plots was obtained by applying 0.5 pound per acre of trifluralin preemergent and lightly incorporated.

The wheat companion crop had a poor stand from poor emergence. The resulting poor competition allowed the sweetclover to emerge from the wheat canopy near harvest of the wheat. Wheat grain and some sweetclover growing points were harvested in early August at a 12-inch stubble height. All clear-seeded plots were unharvested in 1983. All plots had the overwintering residue removed prior to extensive spring growth. All plots were harvested for forage on June 21, 1984 at the 40 to 80 pecent bloom growth stage.

Experiment 2 in 1984 was a repeat of Experiment 1 except that only a good seed lot was used. Competition from the wheat companion crop resulted in the emerged seedlings dying before grain harvest, so no forage yields for a companion crop treatment are presented in the 1985 data.

Experiment 3 was intended to be seeded at 2, 4, 6, 8, and 12 pounds per acre, but a planting error resulted in seeding rates about 20 percent greater. A hard 1-inch rain caused some crusting, but stands appeared adequate following a plant density count. All other procedures were similar to Experiment 2.

Experiment 4 compared the yield performance of six sweetclover cultivars, Goldtop, Madrid, Denta, Norgold, Arctic, and Yukon, following clear seeding. The experiment was seeded at 12 pounds per acre in late April at Fargo in 1981 and June 2, 1982. All stands were considered excellent. Sweetclover forage was harvested with a sickle-bar mower at a 4- to 5-inch stubble height on August 10, 1981, June 16, 1982, and June 20, 1983. The 1982 seeding was not harvested in the seeding year. Samples of forage from the June 16 harvest were analyzed for dicoumarol.

Experiment 5 compared the yield performance of five sweetclover cultivars, Madrid, Norgold, Polara, Yukon, and yellow-flowered common, following clear seeding. The experiment was seeded at 10 pounds per acre in mid May at Streeter in 1983. No seeding-year harvest was taken, but extensive deer grazing was noted in late fall.

Experiment 6 compared the yield performance of seven sweetclover cultivars, the same as Experiment 5 plus Goldtop and Denta, following clear seeding and harvested or unharvested in the seeding year. The experiment was seeded broadcast on May 13, 1987 at Fargo. Half of the plots were harvested at a 5-inch stubble height on August 10, 1987 when seeding-year growth appeared to have ceased. Some recovery growth occurred on all harvested plots. Overwintering residue was removed from all plots prior to initiation of growth. Stand estimates were taken on April 24, 1988. Forage was harvested on June 2 and July 18, 1988 at a 2-inch stubble height.

Seeding Rate

Forage yield of clear-seeded sweetclover was unaffected by the seeding rate in 1984 and 1987 (Table 1). Significant differences by seeding rate were detected in 1985. Plots with the 2-pound per acre seeding rate yielded less than higher seeding rates. Likewise, forage yields of companion crop established plots were unaffected by the seeding rate and very similar to those from clear-seeded plots. Scarified or 70 percent hard seed in the pods established equally productive stands either clear-seeded or seeded with companion crop.

Plant density increased with increasing seeding rate as expected (Table 2). Even the 2-pound per acre seeding rate had five to seven seedlings per square foot. Earlier research indicated that as little as five to nine plants per square foot produced near maximum yield of alfalfa in the first-harvest year. Sweetclover appears to be similar to alfalfa in this respect.

Plant density was unaffected by the method of establishment during June 1984, but complete stand failure occurred from companion crop competition by August 1984. The clear-seeded plots in August all had good to excellent stands, except those with the 2-pound per acre

Table 1. Forage yield of sweetclover as affected by seeding rate at Fargo, ND.

Seeding rate	1984 Clear-seeded	1984 Wheat CC[a]	1984 Mean	1985 clear-seeded[b]	1987 clear-seeded[c]
lb/A	Tons dry matter/acre				
2	2.35	2.24	2.29	1.22	4.02
4	2.07	2.27	2.17	1.91	3.51
6	2.53	2.01	2.27	1.96	4.21
8	2.39	2.15	2.27	1.78	3.37
10	2.23	2.30	2.26	2.32	—
12	2.28	2.00	2.14	2.10	3.81
16	2.09	2.28	2.18	1.86	—
20	2.14	2.50	2.30	2.50	—
Mean	2.25	2.22	2.23	1.95	3.78
LSD (0.05)	NS	NS	NS	0.64	NS
CV (%)	13.6	14.1	13.9	18.3	12.6

[a]Len wheat companion crop (CC) seeded at 70 lb/A, but poor stand provided little competition.
[b]Clear-seeded plots only since wheat companion crop did not allow the underseeded sweetclover to establish.
[c]Seeding rate about 20% higher than given due to a planting error.

Table 2. Stand density of sweetclover as influenced by seeding rate and establishment method at Fargo, ND.

Seeding rate	1984 Clear-seeded	1984 Wheat CC[a]	1984 Mean	% est.[b]	1987 clear-seeded	% est.
lb/A	Plants/ft²				Plants/ft²	
2	5	6	6	49	7	50
4	10	14	12	50	14	50
6	14	13	13	38	19	45
8	20	19	19	41	21	37
10	27	28	27	46	—	—
12	34	34	34	48	22	26
16	38	42	37	39	—	—
20	50	52	50	43	—	—
Mean	25	26	25	—	17	—
LSD (0.05)	10.3	11.1	5.5	—	9	—
CV (%)	23.8	24.4	23.1	—	30.5	—

[a]Companion crop
[b]Established

seeding rate. The percentage of seed establishing seedlings ranged from 38 to 50 in 1984 and did not change with seeding rate (Table 2). Conversely, the percent of seed establishing seedlings decreased with increasing seeding rate in 1987, but the range was fairly similar. The difference between years was probably associated with the heavy rainfall during establishment in 1987.

These data suggest that 4-pounds per acre seeding rate of sweetclover is quite adequate for maximum yield in eastern North Dakota. This is in contrast to recommendations of 10 to 12 pounds per acre seeding rates for broadcast stands and 5 to 8 pounds per acre for fields seeded with a drill. These data suggest that a higher seeding rate for broadcast clear-seeded stands than drilled stands is unnecessary, and that the low end of the recommendation is adequate in clear-seeded stands. However, a uniform distribution of seed on a firm seedbed is necessary at this low seeding rate, which may not be possible with some double-disc opener drills.

Table 3. Forage yield of seven sweetclover varieties either harvested or unharvested in the establishment year at Fargo, ND, 1987-88.

	Harvested in 1987									
	1987	1988			2-yr	Unharvested in 1987			1988	
Entry	8-10	6-2	7-18	Total	total	6-2	7-18	Total	mean	1984[a]
	tons dry matter/acre									
Goldtop	1.67	1.35	0.38	1.73	3.40	1.87	0.39	2.26	1.99	—
Madrid	1.63	1.43	0.29	1.72	3.35	1.74	0.36	2.10	1.91	2.01
Denta	1.66	1.05	0.44	1.49	3.15	1.79	0.43	2.22	1.86	—
Norgold	1.63	1.31	0.21	1.51	3.14	1.36	0.35	1.71	1.61	1.87
Polara	1.49	0.97	0.32	1.29	2.78	1.51	0.27	1.78	1.54	1.54
Yukon	1.40	1.41	0.21	1.62	3.02	1.75	0.31	2.06	1.84	1.49
Yellow-flow.	1.57	1.37	0.29	1.67	3.24	1.62	0.45	2.07	1.87	1.84
Mean	1.58	1.27	0.31	1.58[b]	3.15[b]	1.66	0.37	2.03	1.80	1.75
LSD (0.05)	NS	NS	NS	0.39	—	NS	NS	0.39	0.31	NS
CV (%)	10.2	15.8	26.1	12.7	—	15.8	2.61	12.7	12.7	20.3

[a]Forage yields from Streeter, ND, seeded in 1983 and harvested 6-26 at 20-60% bloom. No forage yield taken in 1983, but deer grazed the stand in late fall.

[b]Harvested and unharvested plots significantly different ($P<0.05$) and seeding-year x cultivar interaction nonsignificant. Total forage yield across 1987 and 1988 between harvest and unharvested treatments was significant ($P<0.05$) and the interaction with cultivar nonsignficant.

Table 4. Forage yield and dicoumarol level of six sweetclover cultivars grown at Fargo, ND, in 1981-82.

			Seeding Year			
	Flower	Dicoumarol	1981			1982
Entry	color	level	8-10-81	6-16-82	Total	6-20-83
		mg/kg	tons dry matter/acre			
Goldtop	Yellow	106	2.32	2.50	4.82	—
Madrid	Yellow	70	2.14	2.50	4.64	2.48
Denta	White	5	1.83	1.78	3.61	1.66
Norgold	Yellow	5	1.56	1.92	3.48	1.96
Artic	White	97	1.83	1.47	3.30	1.59
Yukon	Yellow	89	1.87	1.69	3.56	1.92
Mean		62	1.92	1.98	3.90	1.92
LSD (0.05)		62	0.45	0.40	—	0.50

Seeding-Year Harvest

Forage yields of seven sweetclover cultivars either harvested or unharvested in the seeding year are presented in Table 3. Forage yields in 1988 (the second year of the biennial's growth) of unharvested treatments were significantly greater than harvested treatments. The reduced growth is probably due to less root development and less root reserves in harvested than unharvested treatments. Likewise, spring vigor ratings were poorer from harvested than nonharvested plots indicating possible winter injury.

General growth and ground cover before harvest indicated that Arctic and, to a lesser degree, Denta and Madrid had poorer growth in harvested than unharvested plots. However, total yields across the three harvests in 1987 and 1988 were more than 50 percent greater in the harvested compared with the unharvested treatments, and the cultivar by harvest treatment interaction was not significant (Table 3).

Bloom ratings at harvest in the second year were similar between harvested and unharvested plots except for the yellow-flowered common, which had 30 percent less bloom. Seeding-year harvest in 1981 (Table 4) of six sweetclover cultivars also did not apparently affect dramatically the second-year harvest yields, because second-year yields of the 1981 seeding were similar to the 1982 seeding which was not harvested in the seeding year.

These data suggest that a seeding-year harvest is possible if haying of set-aside acreage is permitted without decreasing the second-year yield to unacceptable levels. However, harvest must occur early so adequate growth of the crown can occur prior to fall dormancy to prevent extensive winter kill.

Cultivar Effects

Significant cultivar effects were detected in three of four environments tested (Tables 3 and 4). Generally, the yellow-flowered, high-coumarin cultivars, Goldtop, Madrid, Yukon, and yellow-flowered common, were the highest yielding in all environments. The white-flowered, high-coumarin cultivar Arctic generally yielded less than the yellow-flowered cultivars.

Low-coumarin cultivars generally yielded less than the high-coumarin, yellow-flowered cultivars, but were equal to or slightly better than Arctic. Norgold's yield was reduced in the seeding year in 1981 due to differential grazing by jackrabbits. Apparently, the low-coumarin cultivars have a greater palatability, which would be expected when the bitter-tasting coumarin content is reduced.

These data suggest that the high-coumarin cultivars should be used for green manure cropping on set-aside acreage due to the greater forage yield potential, which is strongly associated with a greater nitrogen yield. However, the low-coumarin cultivar Norgold (yellow flowered) or Polara (white flowered) should be considered if a forage harvest is contemplated, to help prevent the potential sweetclover bleeding disease.

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