

# Seeding Rate Effect on Irrigated Three-cut Alfalfa Forage Production

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## Abstract

Alfalfa is an important crop for central Oregon. As inputs increase in cost, and with the release of Roundup Ready<sup>®</sup> alfalfa (Monsanto), seeding rate effects on yield warranted another look. Seeding rates for establishing an alfalfa field have continued to creep upward over the years. Cost of alfalfa seed has increased over the years; and Roundup Ready alfalfa seed price plus the additional technology fee raise the price even higher. Seeding rates of 4 to 32 lb/acre, in 4-lb increments (seed germination of 78 percent) were planted at the Central Oregon Agricultural Research Center Powell Butte site in August of 1998. The trial was conducted as a 3-cut harvest management regime and was run from 1999 to 2003. The range in yield was 35.41 ton/acre (4-lb/acre seed rate) to 36.66 ton/acre (32-lb/acre seed rate). The 37.52 ton/acre yield from the 24-lb/acre seed rate was the highest numerical yield. None of the seeding rates were significantly different from each other for annual cumulative or annual individual year yields. There were significant differences for annual average stems/ft<sup>2</sup> for the first 3 years of the trial. Reduced stems/ft<sup>2</sup> compensated for yield with heavier stem weights.

## Introduction

All hay ranks number two in farm gate dollar value for the central and eastern Oregon agricultural economies. Over the years, there has been a range of perhaps 35,000 to 50,000 acres of pure alfalfa stands grown in the three central Oregon counties. Alfalfa is grown in pure stands and grass/alfalfa mixtures for hay. Local hay produced is marketed to livestock producers, dairies, and feed stores in Oregon, Washington, Idaho, California, and Canada. Some alfalfa from the region is exported to Pacific Rim countries. Alfalfa is an important rotational crop that breaks disease and insect problem cycles and adds nitrogen to the soil through natural fixation for subsequent crops, reducing N inputs and saving money.

Extension seeding rate recommendations have been in the range of 12-15 lbs/acre. Over the years, seeding rates have continued to creep upwards, sometimes with planting rates of 25 to 30 lbs of seed/acre. Seed cost for private alfalfa varieties has continued to increase over the years along with the increased seeding rates. With the release of Roundup Ready alfalfa, with seed cost plus technology fee, the cost per pound of alfalfa seed has reached an all time high. Hay prices, while perhaps "profitable" over the years, in general have not kept pace with the cost of inputs. The only previous alfalfa plant population study (comparing the range of two-thirds of a plant to eight plants/ft<sup>2</sup> in a three-cut trial) was conducted from 1973-1975 (Murphy et al. 1976).

Our objectives were to evaluate seeding rates with an improved variety of alfalfa to see if reduced seeding rates would have any detrimental effect on yield and longevity. Seed cost at establishment is amortized over the life of the stand and is not a great input cost. There could be a fair amount of potential savings if seeding rates for traditional varieties and especially Roundup Ready<sup>®</sup> varieties could be reduced.

## Materials and Methods

Soil samples were taken and analyzed by the Oregon State University Plant and Soil Analytical Laboratory, Corvallis Oregon (Table 1). Based on the soil test results, lime, phosphorus, potassium, sulfur, and boron were applied and incorporated (disked) into the top 6 inches of soil on April 18, 1998 (Table 2.). The field was then leveled and rolled prior to planting.

Table 1. Soil test analyses from alfalfa variety, fall dormancy, and seeding rate trials from soil samples taken at the Central Oregon Agricultural Research Center, Powell Butte, Oregon.

Date	Depth (in)	OM (%)	pH	P (ppm)	K (ppm)	Ca (meq/100g)	Mg (meq/100g)	B (ppm)	Zn (ppm)	Sol Salts Mmhos/cm	Se (ppm)	Mn (ppm)	Total Bases
7/10/1995	0-12	3.33	5.7	40	230	6.0	2.6	0.34		0.50			
8/3/1998	0-10		5.8	47	177	6.0	2.5	0.40	0.6	--	--	15	9.0
3/2000	0-10		7.2	33	216	7.1	2.4	0.50	0.32	0.50	<0.10*		
4/2002	0-10		6.6	48	238	9.3	2.6	0.59	5.57				

\* below the minimum detectable level.

Table 2. Nutrient applied to the alfalfa variety, fall dormancy, and seeding rate trials at the Central Oregon Agricultural Research Center, Powell Butte, Oregon.

Date applied	N (lb/acre)	P2O5 (lb/acre)	K2O (lb/acre)	Ca (lb/acre)	S (lb/acre)	B (lb/acre)	Zn (lb/acre)
4/11/1998	19	0	217	5,000	14	2.2	0
4/17/1998	28	0	0	172	32	0	0
3/24/1999	0	72	144	202	38	0	0
3/24/2000	0	72	144	202	38	0	0
3/23/2001	0	96	191	183	34	1.5	7.7
3/29/2002	0	96	191	183	34	0	0
2003	0	0	0	336	64	0	0

‘Ultra’ alfalfa variety (Table 3) was planted at the Central Oregon Agricultural Research Center (COARC) at the Powell Butte site, on August 24, 1998. The trial site is located 7 miles west of Prineville or 12 miles east of Redmond and the elevation is 3,180 ft. Total seeding rates of 4, 8, 12, 16, 20, 24, 28, and 32 lbs/ acre of inoculated seed were planted with a small-plot cone-type drill with 9 rows, 6-inch row spacing. The germination of the seed was 78 percent. The field was rolled after planting. Plot size was 5 by 20 ft, while harvested area was approximately 3.5 by 15 ft. At every harvest, every other plot was measured for length, with the middle plot length averaged.

Table 3. The fall dormancy, winter hardiness, disease, insect, and pest ratings for the 1998 planted alfalfa fall dormancy variety trial conducted at COARC, Powell Butte, Oregon.

Variety	FD <sup>1</sup>	WS	Bw	Vw	Fw	An	PRR	SAA	PA	BAA	SN	APH	SNKN	NRKN	RLN
Ultra	3 <sup>2</sup>	4	R <sup>3</sup>	R	HR	HR	R	LR	R	S	R	S	S	S	S

<sup>1</sup>FD = Fall Dormancy, WH = Winter Hardiness, BW = Bacterial Wilt, VW = Verticillium Wilt, FW = Fusarium Wilt, AN = Anthracnose Race 1, PRR = Phytophthora Root Rot, SAA = Spotted Alfalfa Aphid, PA = Pea Aphid, BAA = Blue Alfalfa Aphid, SN = Stem Nematode, APH = Aphanomyces, SKN = Southern Root Knot Nematode, NRKN = Northern Root Knot Nematode, RLN = Root Lesion Nematode.

<sup>2</sup>Fall Dormancy (FD) ratings: 1 = most dormant, 11 = least dormant. Winter Survival (WS: 1 = most winter hardy, 6 = least winter hardy).

<sup>3</sup>Resistance Ratings: S = Susceptible (0-5 percent of plants) or has not been tested, LR = Low Resistance (5-15 percent), MR = Moderate Resistance (15-30 percent of plants), R = Resistance (30-50 percent of plants), HR = High Resistance (>50 percent of plants).

The alfalfa was harvested with a sickle bar forage plot harvester, and fresh wet yield was weighed directly in the field. Aftermath from the plots was swathed, raked, and baled with fairly high moisture content (rather than waiting for typical moisture to bale) to help clear the field and get the irrigation water back on the field as soon as possible, typically within 5-7 days. Harvest dates are listed for each cutting in the annual yield tables.

Moisture samples (0.5 to 1.0 lb) were taken for each plot, with wet weight weighed in the field, and then dried at 145°F until no further change in weight occurred. Yields are presented on an oven-dry, dry matter basis.

The trial was solid-set, sprinkler irrigated with a 30- by 40-ft spacing as needed for establishment and during the season. Nelson rotating head Windfighter 2000 nozzles (Nelson Irrigation Corp., Walla Walla Washington) were used. Irrigation is determined by crop water use prediction by the AgriMet weather station program and by probing the soil with a soil probe. There is an AgriMet weather station located at COARC. The trial was usually irrigated two times per week, depending upon time of year. Between the second and third cutting in 2001 the irrigation heads/nozzles were changed from 7/64-inch to 9/64-inch Nelson rotating head Windfighter 2000 nozzles.

Pursuit<sup>®</sup> (1 DG Eco Pak bag), Poast<sup>®</sup> (0.47 lb/acre a.i.) and 2 quarts of crop oil were applied for weed control September 17, 1998 of the establishment year. The first winter dormant weed control included applying Velpar<sup>®</sup> L (0.75 lb/acre a.i.), Gramoxone Extra<sup>®</sup> (0.5 lb/acre a.i.) and Kerb<sup>®</sup> (1 lb/acre a.i.) on February 9, 2000. Velpar L (0.75 lb/acre a.i.), Kerb (1 lb/acre a.i.), and Gramoxone Extra (0.5 lb/acre a.i.) were applied on December 6, 2000 for the third production year. Velpar (0.5 lb/acre a.i.), Gramoxone Extra (0.5 lb/acre a.i.), and Spredor 90<sup>®</sup> (1 pt/100 gal) were applied on January 15, 2002 for the fourth production year. For the 2003 crop year, Sencor<sup>®</sup> (0.4 lb/acre a.i.), Gramoxone (0.5 lb/acre a.i.) and Spredor 90 (1 pt/100 gal) were applied in February.

On June 30, 2000, Baythroid<sup>®</sup> (2.88 oz/acre) was applied by aerial application to control alfalfa weevil.

The trial was laid out in a randomized block design with four replications. SAS statistical software (SAS Institute, Inc., Cary, North Carolina) was used for analysis of variance and results are reported using Protected Least Significant Difference (PLSD) for mean separation at the P = 0.10, 0.05, and 0.01 probability level. Discussion of results and is limited to the PLSD 0.10 level, unless otherwise stated.

## **Results**

Weed control was excellent and winters were relatively mild for the 5 years of the trial. Harsh winter weather was not a factor in the trial.

### ***Cumulative and Annual Results (Tables 4 and 5)***

There were no statistical differences between seeding rates for cumulative yield from year 1 to year 5, nor were there any significant total annual yield differences for any individual year. The yield range for the 4- to 32-lb/acre seeding rate was 35.41 ton/acre to 36.66 ton/acre (highest yield was 37.52 ton/acre for the 24-lb/acre seeding rate).

Cumulative average number of stems/ft<sup>2</sup> were significantly different for all of the cumulative years. There were differences in average annual stem numbers between seeding rates for the first 3 years, but there were no statistical differences in the fourth and fifth year. Even in the second and third year of production, while there were significant differences, there was not always an increasing stem number with each increased seeding rate treatment.

In the first year, the annual average number of stems/ft<sup>2</sup> for the 32-lb/acre seed rate was approximately double that of the 4-lb/acre seed rate. The annual average number of stems for the lower seeding rates did not decrease as much over the years and stayed relatively constant compared to the higher seeding rates, which dramatically decreased over time. The annual average number of stems at year 5, compared to the first year was 92, 82, 75, 61, 63, 58, 57, and 52 percent for the 4-, 8-, 12-, 16-, 20-, 24-, 28-, and 32-lb/acre seeding rates respectively. The average stem number range was only 62.0 to 68.5 stems/ft<sup>2</sup>, from low to high seeding rates in the fifth year of production.

Table 4. Cumulative yield and average cumulative stems/ft<sup>2</sup> for the ‘Ultra’ alfalfa seeding rate trial planted on August 24, 1998 and managed under a three-cut harvest regime at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate (lb/acre) - PLS*	1-year total yield (ton/acre)	1-year avg. stems per ft <sup>2</sup>	2-year total yield (ton/acre)	2-year avg. stems per ft <sup>2</sup>	3-year total yield (ton/acre)	3-year avg. stems per ft <sup>2</sup>	4-year total yield (ton/acre)	4-year avg. stems per ft <sup>2</sup>	5-year total yield (ton/acre)	5-year avg. stems per ft <sup>2</sup>
4 - 3.1	7.18	69.4	14.68	72.4	22.87	72.6	29.27	72.6	35.41	70.7
8 - 6.2	7.83	81.4	15.50	80.9	23.94	80.0	30.44	77.6	36.70	75.1
12 - 9.4	7.80	90.6	15.44	91.1	23.83	85.5	30.66	83.2	37.00	79.6
16 - 12.5	7.76	103.5	15.43	94.2	23.87	89.2	30.62	85.9	37.13	81.8
20 - 15.6	7.84	108.9	15.26	100.0	23.45	94.1	30.19	89.2	37.07	84.8
24 - 18.7	8.02	107.7	15.68	101.0	24.20	94.0	30.91	87.8	37.52	83.2
28 - 21.8	7.86	115.0	15.33	100.6	23.61	93.5	30.61	88.3	37.27	83.3
32 - 25.0	7.53	126.5	15.18	112.0	23.32	101.9	30.10	95.0	36.66	89.4
Mean	7.73	100.4	15.31	94.0	23.64	88.8	30.35	85.0	36.84	81.0
PLSD 0.01	NS	20.8	NS	15.0	NS	10.7	NS	9.5	NS	8.9
PLSD 0.05	NS	15.4	NS	11.0	NS	7.9	NS	7.0	NS	6.6
PLSD 0.10	NS	12.6	NS	9.1	NS	6.5	NS	5.8	NS	5.4
CV %	4.9	10.4	3.8	8.0	3.5	6.0	3.1	5.6	2.8	5.5
Pr. > F	0.1257	0.0001	0.4102	0.0001	0.4394	0.0001	0.3601	0.0001	0.2057	0.0002

\*PLS = pure live seed.

Table 5. 1999-2003 annual yield and average stems/ft<sup>2</sup> results for the ‘Ultra’ alfalfa seeding rate trial managed under a three-cut harvest management regime at the Central Oregon Agricultural Research Center, Powell Butte, Oregon.

Seeding rate (lb/acre) - PLS	1999 total yield (ton/acre)	1999 avg. stems per ft <sup>2</sup>	2000 total yield (ton/acre)	2000 avg. stems per ft <sup>2</sup>	2001 total yield (ton/acre)	2001 avg. stems per ft <sup>2</sup>	2002 total yield (ton/acre)	2002 avg. stems per ft <sup>2</sup>	2003 total yield (ton/acre)	2003 avg. stems per ft <sup>2</sup>
4 - 3.1	7.18	69.4	7.49	75.4	8.20	72.9	6.40	72.6	6.14	63.0
8 - 6.2	7.83	81.4	7.67	80.3	8.44	78.2	6.50	70.5	6.26	65.1
12 -9.4	7.80	90.6	7.64	91.6	8.39	74.3	6.83	76.4	6.34	65.0
16-12.5	7.76	103.5	7.68	84.9	8.43	79.2	6.75	76.0	6.51	65.1
20-15.6	7.84	108.9	7.43	91.2	8.19	82.3	6.74	74.3	6.87	67.5
24-18.7	8.02	107.7	7.65	94.2	8.53	80.0	6.71	69.3	6.61	64.8
28-21.8	7.86	115.0	7.47	86.2	8.29	79.4	7.00	72.6	6.66	63.5
32-25.0	7.53	126.5	7.65	97.5	8.14	81.8	6.77	74.1	6.56	67.3
Mean	7.73	100.4	7.58	87.7	8.33	78.5	6.71	73.2	6.49	65.2
PLSD 0.01	NS	20.8	NS	NS	NS	NS	NS	NS	NS	NS
PLSD 0.05	NS	15.4	NS	11.9	NS	NS	NS	NS	NS	NS
PLSD 0.10	NS	12.6	NS	9.8	NS	5.7	NS	NS	NS	NS
CV %	4.9	10.4	4.3	9.2	3.7	5.9	4.3	7.1	6.5	11.0
Prob.	0.1257	0.0001	0.8974	0.0149	0.5874	0.0961	0.1762	0.5127	0.3149	0.9814

*1999 Results*

*First cutting (Table 6):* The 4-lb/acre (3.1 lbs pure live seed [PLS]/acre actual) seeding rate yielded less than the other seeding rates ( $P > F = 0.1012$ ). The seeding rates of 8-32 lb/acre all yielded similarly. There was almost a two-fold difference in stems/ft<sup>2</sup> as seeding rates increased. There was a significant inverse relationship for stem weight as seeding rate increased. Lodging increased significantly as seeding rates increased, up to almost 50 percent (at the 24 lb rate) and then decreased, although not significantly.

*Second cutting (Table 7):* The 4- through 28-lb/acre rates had similar yields, but the 32-lb/acre rate yield was significantly lower than all other rates. As seeding rates increased, stems/ft<sup>2</sup> increased (more than doubled). In general, the two lower seeding rates had lower lodging rates, and as seeding rates increased, lodging increased up to the 28- and 32-lb/acre rates. The stem weights were significantly different. As seeding rates increased, stem weight decreased.

*Third cutting (Table 8):* There were no differences in yield between the seeding rates. As seeding rates increased, stems/ft<sup>2</sup> increased up to the 16- through 28-lb/acre rate; there was a trend for the 32-lb/acre rate to be higher, but not significantly so. There were no significant differences for stem weight.

Table 6. First cutting 1999 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Lodge (%)	Stem wt. (g)
4 - 3.1	2.93	19.6	80.4	68.4	0.0	0.90
8 - 6.2	3.57	19.9	80.1	73.4	2.5	1.07
12 - 9.4	3.60	20.4	79.6	80.2	12.5	0.94
16 - 12.5	3.48	20.2	79.8	100.3	26.3	0.73
20 - 15.6	3.56	20.3	79.7	101.8	33.8	0.73
24 - 18.7	3.53	20.2	79.8	105.5	47.5	0.71
28 - 21.8	3.62	20.6	79.4	120.9	32.5	0.63
32 - 25.0	3.58	21.3	78.7	124.6	27.5	0.62
Mean	3.49	20.3	79.7	96.9	22.8	0.792
PLSD 0.01	NS	NS	NS	25.5	NS	0.28
PLSD 0.05	NS	NS	NS	18.7	27.3	0.21
PLSD 0.10	(0.39)	NS	NS	15.5	22.5	0.17
CV %	9.2	4.2	1.1	13.1	81.2	17.8
Pr. > F	0.1012	0.2324	0.2324	0.0001	0.0192	0.0014
Harvest date	6/18					

Table 7. Second cutting 1999 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Lodge (%)	Stem wt. (g)
4 - 3.1	2.01	17.6	82.4	66.0	20.0	0.68
8 - 6.2	1.95	16.9	83.1	93.5	35.0	0.46
12 - 9.4	1.98	16.6	83.4	103.4	45.0	0.41
16 - 12.5	1.91	17.1	82.9	113.2	62.5	0.35
20 - 15.6	1.93	17.2	82.8	127.8	60.0	0.32
24 - 18.7	1.98	17.6	82.4	129.3	57.5	0.33
28 - 21.8	1.93	17.3	82.7	126.6	85.0	0.32
32 - 25.0	1.70	16.7	83.3	143.2	81.3	0.25
Mean	1.93	17.1	82.9	112.9	55.8	0.39
PLSD 0.01	NS	NS	NS	25.4	36.4	0.17
PLSD 0.05	NS	NS	NS	18.6	26.7	0.13
PLSD 0.10	0.16	NS	NS	15.4	22.1	0.11
CV %	6.9	5.4	1.1	11.2	32.5	22.4
Pr. > F	0.0956	0.6951	0.6951	0.0001	0.0007	0.0001
Harvest date	8/3					

Table 8. Third cutting 1999 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.23	33.8	66.2	73.8	0.66
8 - 6.2	2.31	34.8	65.2	77.3	0.64
12 - 9.4	2.22	33.3	66.7	88.1	0.53
16 - 12.5	2.37	34.2	65.8	97.0	0.51
20 - 15.6	2.34	33.4	66.6	97.1	0.53
24 - 18.7	2.51	33.8	66.2	88.2	0.60
28 - 21.8	2.30	35.0	65.0	97.5	0.50
32 - 25.0	2.24	34.2	65.8	111.7	0.42
Mean	2.32	34.1	65.9	91.3	0.55
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	20.5	NS
PLSD 0.10	NS	NS	NS	16.9	NS
CV %	11.8	4.6	2.4	15.2	24.1
Pr. > F	0.8466	0.7279	0.7279	0.0216	0.2485
Harvest date	9/30				

*2000 Results*

*First cutting (Table 9):* There were no yield differences. There were differences in stems/ft<sup>2</sup>, but not greatly so. There were differences for stem weight, but not straightforward differences as seeding rates increased.

*Second cutting (Table 10):* There were no differences in yield, numbers of stems, nor stem weight.

*Third cutting (Table 11):* There were no differences in yield. The 4-lb/acre seed rate did produce significantly fewer stems/ft<sup>2</sup> than the 8-lb/acre rate, though the 8-lb rate was not different from the 12- to 28-lb/acre rates, but was less than the 32-lb/acre rate, and had more stems than the 16-lb rate. There was a significant inverse relationship for stem weight.

Table 9. First cutting 2000 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.59	21.2	78.8	89.7	0.60
8 - 6.2	2.84	21.4	78.7	86.7	0.68
12 - 9.4	2.84	21.5	78.5	101.9	0.58
16 - 12.5	2.72	21.4	78.6	93.9	0.61
20 - 15.6	2.66	21.5	78.5	101.1	0.55
24 - 18.7	2.81	22.2	77.8	109.1	0.54
28 - 21.8	2.78	20.7	79.3	88.3	0.66
32 - 25.0	2.87	22.0	78.0	101.9	0.59
Mean	2.76	21.5	78.5	96.6	0.60
PLSD 0.01	NS	NS	NS	15.8	NS
PLSD 0.05	NS	NS	NS	11.6	0.09
PLSD 0.10	NS	NS	NS	9.6	0.08
CV %	8.3	4.3	1.2	8.2	10.4
Pr. > F	0.6435	0.5045	0.5045	0.0050	0.0441
Harvest date	6/6				

Table 10. Second cutting 2000 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.30	16.4	83.6	80.5	0.60
8 - 6.2	2.37	17.2	82.7	84.2	0.60
12 - 9.4	2.34	16.8	83.2	93.8	0.53
16 - 12.5	2.33	16.8	83.2	88.9	0.55
20 - 15.6	2.34	17.0	83.0	92.0	0.53
24 - 18.7	2.33	16.7	83.3	94.2	0.52
28 - 21.8	2.31	16.4	83.6	93.4	0.52
32 - 25.0	2.25	17.1	82.9	102.2	0.47
Mean	2.32	16.8	83.2	91.2	0.54
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	NS	NS
CV %	6.4	3.7	0.7	14.0	16.2
Pr. > F	0.9769	0.4034	0.4034	0.4010	0.4735
Harvest date	7/19				

Table 11. Third cutting 2000 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.60	21.8	78.2	55.8	1.01
8 - 6.2	2.47	22.1	77.9	70.2	0.77
12 - 9.4	2.46	21.0	79.0	79.1	0.65
16 - 12.5	2.62	22.1	77.9	71.8	0.77
20 - 15.6	2.43	20.6	79.4	80.4	0.63
24 - 18.7	2.51	21.2	78.8	79.3	0.67
28 - 21.8	2.38	20.9	79.1	77.0	0.65
32 - 25.0	2.53	21.8	78.2	88.2	0.60
Mean	2.50	21.4	78.6	75.2	0.72
PLSD 0.01	NS	NS	NS	15.8	NS
PLSD 0.05	NS	NS	NS	14.7	0.21
PLSD 0.10	NS	NS	NS	12.2	0.18
CV %	6.1	4.5	1.2	13.3	20.2
Pr. > F	0.3388	0.2936	0.2936	0.0097	0.0163
Harvest date	9/13				

2001

*First cutting (Table 12):* There were no yield or stem weight differences between seeding rates. There were significant differences between seeding rates for stems/ft<sup>2</sup> in general.

*Second cutting (Table 13):* There were no differences in yield, stem numbers, or stem weight.

*Third cutting (Table 14):* There were no differences in yield, stem numbers, or stem weight.

Table 12. First cutting 2001 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.99	24.0	76.0	77.8	0.81
8 - 6.2	3.19	23.5	76.5	73.3	0.92
12 - 9.4	3.14	22.7	77.3	78.5	0.85
16 - 12.5	3.11	23.5	76.5	82.5	0.80
20 - 15.6	3.10	22.8	77.2	88.4	0.74
24 - 18.7	3.20	23.2	76.8	88.4	0.76
28 - 21.8	3.15	23.3	76.7	74.2	0.89
32 - 25.0	3.00	22.4	77.6	86.2	0.73
Mean	3.11	23.2	76.8	81.2	0.81
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	8.7	NS
CV %	4.3	4.1	1.2	10.2	12.6
Pr. > F	0.2692	0.3807	0.3807	0.0837	0.1233
Harvest date	6/13				

Table 13. Second cutting 2001 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.96	19.7	80.3	73.3	0.84
8 - 6.2	3.07	20.3	79.7	82.0	0.79
12 - 9.4	3.04	20.2	79.8	75.1	0.85
16 - 12.5	3.10	20.0	80.0	84.6	0.77
20 - 15.6	2.91	19.5	80.5	83.5	0.73
24 - 18.7	2.96	20.1	79.9	77.5	0.81
28 - 21.8	2.92	19.6	80.4	82.0	0.74
32 - 25.0	2.93	19.5	80.5	83.6	0.73
Mean	2.99	19.9	80.1	80.2	0.78
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	NS	NS
CV %	6.3	3.4	0.8	8.9	12.1
Pr. > F	0.7193	0.4988	0.4988	0.2409	0.4691
Harvest date	8/1				

Table 14. Third cutting 2001 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.25	21.2	78.8	67.6	0.72
8 - 6.2	2.18	21.8	78.2	79.3	0.58
12 - 9.4	2.21	20.2	79.8	69.4	0.67
16 - 12.5	2.22	20.9	79.1	70.6	0.66
20 - 15.6	2.17	20.8	79.2	74.9	0.61
24 - 18.7	2.36	21.5	78.5	74.2	0.68
28 - 21.8	2.22	20.8	79.2	81.8	0.57
32 - 25.0	2.21	20.9	79.1	75.7	0.62
Mean	2.23	21.0	79.0	74.2	0.64
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	NS	NS
CV %	7.2	5.2	1.4	11.9	16.7
Pr. > F	0.7875	0.6030	0.6030	0.3399	0.4415
Harvest date	9/19				

2002

*First cutting (Table 15):* There were no differences for yield, stem numbers, or stem weight. The yield for the 4–lb/acre rate trended lower than the rest of the seeding rates.

*Second cutting (Table 16):* There were no differences for yield, stem numbers, and stem weight. Again there was slightly lower yield for the 4- and the 8-lb/acre rates than for the rest of the seeding rates, but not significantly so.

*Third cutting (Table 17):* While there were significant differences between seeding rate yields, there was no clear pattern. There were no differences in stem numbers and stem weight.

Table 15. First cutting 2002 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.07	20.7	79.3	70.7	0.61
8 - 6.2	2.26	21.4	78.6	72.9	0.65
12 - 9.4	2.35	21.4	78.6	78.6	0.64
16 - 12.5	2.37	21.2	78.8	73.5	0.68
20 - 15.6	2.36	21.0	79.0	83.5	0.60
24 - 18.7	2.43	20.6	79.4	78.6	0.65
28 - 21.8	2.42	21.3	78.7	80.0	0.63
32 - 25.0	2.31	20.8	79.2	75.7	0.64
Mean	2.32	21.0	79.0	76.7	0.64
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	NS	NS
CV %	8.4	3.6	1.0	10.5	15.6
Pr. > F	0.2661	0.7208	0.7208	0.3991	0.9753
Harvest date	6/12				

Table 16. Second cutting 2002 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	1.91	17.3	82.7	80.9	0.50
8 - 6.2	1.90	16.6	83.4	77.0	0.52
12 - 9.4	2.04	16.6	83.4	82.4	0.53
16 - 12.5	2.08	16.5	83.5	85.8	0.51
20 - 15.6	2.06	17.2	82.8	70.6	0.62
24 - 18.7	2.01	16.9	83.1	72.0	0.59
28 - 21.8	2.05	16.4	83.6	79.0	0.54
32 - 25.0	2.04	17.1	82.9	80.4	0.53
Mean	2.01	16.8	83.2	78.5	0.54
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	NS	NS
CV %	6.7	2.9	0.6	12.4	14.0
Pr. > F	0.4814	0.1180	0.1180	0.3818	0.3500
Harvest date	7/17				

Table 17. Third cutting 2002 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.42	19.2	80.8	66.3	0.76
8 - 6.2	2.34	19.2	80.8	61.7	0.79
12 - 9.4	2.44	18.9	81.1	68.1	0.75
16 - 12.5	2.31	18.8	81.2	68.8	0.71
20 - 15.6	2.33	18.7	81.3	68.9	0.72
24 - 18.7	2.27	19.0	81.0	57.5	0.83
28 - 21.8	2.52	19.4	80.6	58.9	0.90
32 - 25.0	2.43	19.5	80.5	66.2	0.78
Mean	2.38	19.1	80.9	64.6	0.78
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	0.14	NS	NS	NS	NS
CV %	4.8	2.6	0.6	14.8	14.0
Pr. > F	0.0786	0.3016	0.3016	0.5097	0.3337
Harvest date	9/3				

2003

*First cutting (Table 19):* There were no differences for yield, stem numbers, or stem weight, for the different seeding rates. There was a trend for yield increasing as seeding rates increased up to the 20- to 28-lb/acre rate, with the 32-lb/acre rate yielding the same as the 8-lb rate.

*Second cutting (Table 20):* There were no significant differences for yield, stem numbers, or stem weight, although there was a trend for increased yield with increasing seed rates up to the 20- to 24-lb/acre rates.

*Third cutting (Table 21):* There were no differences in yield, stem numbers, or stem weight, for the different seeding rates. There was a small trend for the higher seeding rates to outyield the 4- to 12-lb/acre rates, with the exception of the 24-lb rate.

Table 19. First cutting 2003 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	1.95	18.8	81.2	60.7	0.68
8 - 6.2	2.10	19.6	80.4	64.0	0.69
12 - 9.4	2.12	19.7	80.3	65.7	0.69
16 - 12.5	2.18	20.7	79.3	67.4	0.69
20 - 15.6	2.31	20.0	80.0	69.3	0.72
24 - 18.7	2.25	19.8	80.2	64.9	0.72
28 - 21.8	2.25	19.9	80.1	60.9	0.80
32 - 25.0	2.08	19.4	80.6	65.8	0.67
Mean	2.15	19.7	80.3	64.8	0.71
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	NS	NS
CV %	8.5	4.9	1.2	14.1	18.9
Pr. > F	0.2016	0.3206	0.3206	0.8764	0.9096
Harvest date	6/16				

Table 20. Second cutting 2003 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.10	17.4	82.6	70.2	0.63
8 - 6.2	2.10	17.3	82.7	75.3	0.60
12 - 9.4	2.14	16.9	83.1	68.1	0.69
16 - 12.5	2.18	17.4	82.6	58.6	0.78
20 - 15.6	2.34	17.5	82.5	69.6	0.71
24 - 18.7	2.28	17.5	82.5	69.0	0.70
28 - 21.8	2.15	17.3	82.7	73.6	0.64
32 - 25.0	2.14	17.4	82.6	68.5	0.66
Mean	2.18	17.4	82.6	69.1	0.67
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	NS	NS
CV %	6.1	2.9	0.6	17.2	19.0
Pr. > F	0.1746	0.7611	0.7611	0.6762	0.6187
Harvest date	7/25				

Table 21. Third cutting 2003 yield and other agronomic results of the alfalfa seeding rate trial planted on August 24, 1998 at the Central Oregon Agricultural Research Center at Powell Butte, Oregon.

Seeding rate actual - PLS (lb/acre)	Yield (ton/acre)	DM (%)	Moist. (%)	Stems (per ft <sup>2</sup> )	Stem wt. (g)
4 - 3.1	2.08	21.2	77.8	58.1	0.75
8 - 6.2	2.06	21.4	78.6	56.0	0.79
12 - 9.4	2.08	21.9	78.1	61.1	0.73
16 - 12.5	2.14	21.4	78.6	69.4	0.65
20 - 15.6	2.23	22.1	77.9	63.7	0.71
24 - 18.7	2.09	21.8	78.2	60.4	0.75
28 - 21.8	2.25	22.4	77.6	55.9	0.82
32 - 25.0	2.34	21.6	78.4	67.7	0.64
Mean	2.16	21.7	78.3	61.5	0.73
PLSD 0.01	NS	NS	NS	NS	NS
PLSD 0.05	NS	NS	NS	NS	NS
PLSD 0.10	NS	NS	NS	NS	NS
CV %	11.0	3.1	0.9	16.3	16.2
Pr. > F	0.6250	0.2717	0.2717	0.4448	0.4104
Harvest date	9/16				

## Discussion

Only the first and second cutting in the first year of the trial (1999) came close to showing any statistical differences for yield between the seeding rates. The 4-lb/acre seeding rate trended lower compared to the rest of the seeding rates on first cutting ( $P > F = 1012$ ). For the second cutting, there were significant differences, but only the 32-lb/acre rate was significantly different from the rest of the seeding rates. Beyond those two cuttings there were no differences, and the two effects tended to cancel each other out.

The 5-year cumulative yield ranged from 35.41 ton/acre (4-lb [3.1 lb PLS]/acre seed rate) to 36.66 ton/acre (32-lb [25.0 lb PLS]/acre seed rate), a difference of only 1.25 ton/acre, which is not statistically significantly different. The largest range between seeding rates was 2.11 ton/acre (37.52 ton/acre for the 24-lb/acre rate). There were no annual yield differences between seeding rates.

Cumulative annual average stem numbers were different for all 5 years. During the first 3 years of the trial, there were significant annual average stem number differences, but not in years 4 and 5. First cutting of the fourth year (2002) was the last individual cutting where there were any significant differences for stems/ft<sup>2</sup> between seeding rates. Third cut of the second year (2000) was the last cutting that had significantly different stem weights between seeding rates. Stem weights did increase to compensate for fewer stems/ft<sup>2</sup>.

There appears to be a lot of room to maneuver with lowering seeding rates of alfalfa. One problem with lowering seeding rates is getting even distribution through a drill. This can be accomplished by mixing a carrier with the seed, like fine cracked corn. The lower two seeding rates, of 4 and 8 lb/acre, did not flow evenly out of the small plot drill.

We believe that if the lower seeding rates had been mixed with a carrier product like fine cracked corn, there would have been fewer actual yield differences between the seeding rates. With a carrier, the two low seed rate treatment plots would have been more evenly planted. The drill tended to plant heavier at the beginning of the plot, to less seed at the other end of the plot, sometimes with very little seed at all at the end of the 4-lb/acre rate plot. We believe that if using regular grain drills to plant at low seeding rates, a carrier would need to be used, depending upon rate or other seed mixed in the drill.

If fine-stemmed alfalfa is important for marketing, then an appropriate higher seeding rate may need to be used. Stem diameter was not measured in this trial. Seeding rates are typically amortized over the life of the stand.

Extension Service seeding rate recommendations will remain at 12-15 lb/acre (9-12 lb/acre PLS). Ultimately, producers will need to make their own individual seeding rate decision based on their own situation, quality of seed bed preparation, planting method (drilled, broadcast, or no-till planted), cost of variety seed, and market potential. It appears that seeding costs may be reduced by lowering seeding rates as long as there is good to excellent management, without sacrificing yield or income.

## References

Murphy, W.M., Johnson, M.J. and R.V. Frakes. 1976. Agricultural Experiment Station Oregon State University Special Report 460