

Evaluation of Interseeding Fertilization-Rate Techniques

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Successful interseeding of alfalfa into grassland ecosystems requires that sufficient quantities of nutrients be available for the growing alfalfa plants. The objectives of the interseeding fertilization-rate techniques trials were to determine whether nitrogen or phosphate fertilization provided an advantage for alfalfa plant establishment and, if an advantage were indicated, to determine a thrifty fertilization rate that provided benefits for the alfalfa plant.

Procedure

Interseeding fertilization-rate techniques trial I was established in 1984 on 1.65 acres located at three study sites on the SW $\frac{1}{4}$, NW $\frac{1}{4}$, SE $\frac{1}{4}$, sec. 21; SW $\frac{1}{4}$, NW $\frac{1}{4}$, NE $\frac{1}{4}$, sec. 28; and SE $\frac{1}{4}$, NW $\frac{1}{4}$, NE $\frac{1}{4}$, sec. 28; T. 143 N., R. 96 W., at the Dickinson Research Extension Center Ranch Headquarters. The 20 X 200 foot plots were randomly located within each of six replications. The established plant community was mixed grass prairie. The soils were loam and sandy loam. Anik, Kane, Rangelander, and Travois alfalfas were used for all treatments. The seed was inoculated with rhizobium bacteria. The plots were interseeded 19 November 1984, 15 April 1985, and 15 May 1985, at the seeding rate of 0.50 lbs PLS per row per acre. The nitrogen (N) and phosphate (P₂O₅) fertilizers were tested in separate treatments and applied at the time of seeding as a band in the furrow rows at the rates of 60 lbs N per acre, and 50 lbs and 100 lbs P₂O₅ per acre. A control treatment was interseeded with alfalfa and no fertilizer was added. The furrows were opened with three-inch twisted chisel plow shovels set at ten-foot row spacings (Manske 1985).

Interseeding fertilization-rate techniques trial II was established in 1986 on 0.41 acres located on the SE $\frac{1}{4}$, SW $\frac{1}{4}$, SE $\frac{1}{4}$, sec. 22, T. 143 N., R. 96 W., at the Dickinson Research Extension Center Ranch Headquarters. The 20 X 100 foot plots were arranged in a randomized block design with three replications. The established plant community was mixed grass prairie. The soil was Shambo loam. Travois and Ladak alfalfas were used for all treatments. The seed was inoculated with rhizobium bacteria. The plots were interseeded 22 April 1986, at the seeding rate of 0.50 lbs PLS per acre per row. The nitrogen (N) and phosphate (P₂O₅) fertilizers were mixed together and applied at the rates of 60 lbs N and 60 lbs P₂O₅, 30 lbs

N and 30 lbs P₂O₅, and 0 lbs N and 0 lbs P₂O₅ per acre. The modified interseeding machine was used with the plow shanks set at ten-foot row spacings. The furrows were opened with double straight coulters spaced 3 inches apart, followed by a 3-inch twisted chisel plow shovel, followed by a 12-inch cultivator sweep with the tip removed (Manske 1986). Alfalfa seed from a hydraulically driven jumbo hopper box was delivered to the seedbed through plastic hose and a solid pipe behind the plow shank of the 3-inch twisted chisel plow shovel. Fertilizer from a hydraulically driven jumbo hopper box was delivered to the seedbed, one inch above the alfalfa seed, through plastic hose and a solid pipe behind the plow shank of the 12-inch cultivator sweep. Fertilization rates for trial I and trial II were determined for the land area of the seedbed in the furrow rows.

Alfalfa density was determined by counting plants per meter of row. Plant heights were determined by measuring from soil surface to top of plant. Alfalfa density and heights were collected monthly during June, July, and August. Differences between means were analyzed by a standard paired-plot t-test (Mosteller and Rourke 1973).

Results and Discussion

The alfalfa plant densities (table 1) on the nitrogen (N) fertilizer treatments in fertilization-rate techniques trial I were not significantly different ($P < 0.05$) between the 60 lbs N/acre rate and the 0 lbs N/acre control treatments during the first growing season for the April, May, and November seeding dates. During the second, third, and fourth growing seasons, alfalfa densities were significantly greater ($P < 0.05$) on the 60 lbs N/acre rate treatment than on the 0 lbs N/acre control treatment for the April seeding date. During the second growing season, alfalfa densities were significantly greater ($P < 0.05$) on the 60 lbs N/acre rate treatment than on the 0 lbs N/acre control treatment for the May seeding date. During the third and fourth growing seasons, alfalfa densities were significantly greater ($P < 0.05$) on the 60 lbs N/acre rate treatment than on the 0 lbs N/acre control treatment for the November seeding date. The alfalfa plant heights (table 2) on the nitrogen (N) fertilizer treatments in fertilization-rate techniques trial I were not significantly different ($P < 0.05$) between the 60 lbs N/acre rate and the 0 lbs N/acre control

treatments during each growing season for the April, May, and November seeding dates, except that the plant heights on the 60 lbs N/acre rate treatments were significantly greater ($P<0.05$) than those on the 0 lbs N/acre control treatments during the second growing season for the May seeding date and the first growing season for the November seeding date.

The alfalfa plant densities (table 3) on the phosphate (P_2O_5) fertilizer treatments in fertilization-rate techniques trial I were not significantly different ($P<0.05$) among the 100 lbs P/acre rate, 50 lbs P/acre rate, and the 0 lbs P/acre control treatments during each growing season for the April, May, and November seeding dates, except that the alfalfa densities on the 0 lbs P/acre control treatments were significantly less ($P<0.05$) than those on the 100 lbs P/acre rate and 50 lbs P/acre rate treatments during the fourth growing season for the May and November seeding dates. The alfalfa plant heights (table 4) on the phosphate (P_2O_5) fertilizer treatments in fertilization-rate techniques trial I were not significantly different ($P<0.05$) among the 100 lbs P/acre rate, 50 lbs P/acre rate, and the 0 lbs P/acre control treatments during each growing season for the April, May, and November seeding dates.

The alfalfa plant densities (table 5) on the nitrogen (N) and phosphate (P_2O_5) fertilizer treatments in fertilization-rate techniques trial II were not significantly different ($P<0.05$) between the 30 lbs N and 30 lbs P/acre rate and the 60 lbs N and 60 lbs P/acre rate treatments during each growing season for the Ladak and Travois alfalfa varieties seeded in April, except that the plant densities on the 60 lbs N and 60 lbs P/acre rate treatment were significantly greater ($P<0.05$) than those on the 30 lbs N and 30 lbs P/acre rate treatment during the third and fourth growing seasons for the Travois alfalfa variety. The alfalfa densities on the 0 lbs N and 0 lbs P/acre control treatments were significantly less ($P<0.05$) than those on the 30 lbs N and 30 lbs P/acre rate and 60 lbs N and 60 lbs P/acre rate treatments during the second and third growing seasons for the Ladak alfalfa variety and during the second growing season for the Travois alfalfa variety. The alfalfa plant heights (table 6) on the nitrogen (N) and phosphate (P_2O_5) fertilizer treatments in fertilization-rate techniques trial II were not significantly different ($P<0.05$) among the 60 lbs N and 60 lbs P/acre rate, 30 lbs N and 30 lbs P/acre rate, and 0 lbs N and 0 lbs P/acre control treatments during each growing season for the Ladak and Travois alfalfa varieties seeded in April.

The alfalfa plant density and plant height data from fertilization-rate techniques trials I and II showed that nitrogen fertilizer helped improve alfalfa plant

establishment. The benefits from phosphate fertilizer were less clear from these data, which measured only aboveground parameters. Phosphorus fertilizer helps improve alfalfa seeding success by encouraging root growth.

Evaluation of alfalfa plant density and plant height data for a fertilizer treatment as a percent of the respective values for a nonfertilized control treatment indicates the degree of advantage or disadvantage received from the fertilizer treatment.

The three-year mean alfalfa plant densities on the 60 lbs N/acre rate treatment were 544.8%, 633.3%, and 525.9% of the mean plant densities on the 0 lbs N/acre control treatment for the April, May, and November seeding dates, respectively (table 1). The three-year mean alfalfa plant heights on the 60 lbs N/acre rate treatment were 102.5%, 116.4%, and 97.3% of the mean plant heights on the 0 lbs N/acre control treatment for the April, May, and November seeding dates, respectively (table 2).

The three-year mean alfalfa plant densities on the 50 lbs P/acre rate treatment were 103.5%, 133.3%, and 151.9% of the mean plant densities on the 0 lbs P/acre control treatment for the April, May, and November seeding dates, respectively (table 3). The three-year mean alfalfa plant heights on the 50 lbs P/acre rate treatment were 90.3%, 105.5%, and 98.3% of the mean plant heights on the 0 lbs P/acre control treatment for the April, May, and November seeding dates, respectively (table 4).

The three-year mean alfalfa plant densities on the 100 lbs P/acre rate treatment were 113.8%, 283.3%, and 163.0% of the mean plant densities on the 0 lbs P/acre control treatment for the April, May, and November seeding dates, respectively (table 3). The three-year mean alfalfa plant heights on the 100 lbs P/acre rate treatment were 98.4%, 115.3%, and 88.6% of the mean plant heights on the 0 lbs P/acre control treatment for the April, May, and November seeding dates, respectively (table 4).

The three-year mean alfalfa plant densities on the 30 lbs N and 30 lbs P/acre rate treatment were 149.6% and 114.3% of the mean plant densities on the 0 lbs N and 0 lbs P/acre control treatment, respectively, for the Ladak and Travois alfalfa varieties seeded in April (table 5). The three-year mean alfalfa plant heights on the 30 lbs N and 30 lbs P/acre rate treatment were 107.4% and 100.9% of the mean plant heights on the 0 lbs N and 0 lbs P/acre control treatment, respectively, for the Ladak and Travois alfalfa varieties seeded in April (table 6).

The three-year mean alfalfa plant densities on the 60 lbs N and 60 lbs P/acre rate treatment were 153.4% and 137.5% of the mean plant densities on the 0 lbs N and 0 lbs P/acre control treatment, respectively, for the Ladak and Travois alfalfa varieties seeded in April (table 5). The three-year mean alfalfa plant heights on the 60 lbs N and 60 lbs P/acre rate treatment were 110.6% and 104.8% of the mean plant heights on the 0 lbs N and 0 lbs P/acre control treatment, respectively, for the Ladak and Travois alfalfa varieties seeded in April (table 6).

The treatment with the fertilization rate of 60 lbs N/acre averaged 568.0% of the plant density and 105.4% of the plant height of the 0 lbs N/acre control. The treatment with the fertilization rate of 50 lbs P/acre averaged 129.5% of the plant density and 98.0% of the plant height of the 0 lbs P/acre control. The treatment with the fertilization rate of 100 lbs P/acre averaged 186.7% of the plant density and 100.8% of the plant height of the 0 lbs P/acre control. The treatment with the fertilization rate of 30 lbs N and 30 lbs P/acre averaged 132.0% of the plant density and 104.1% of the plant height of the 0 lbs N and 0 lbs P/acre control. The treatment with the fertilization rate of 60 lbs N and 60 lbs P/acre averaged 145.4% of the plant density and 107.7% of the plant height of the 0 lbs N and 0 lbs P/acre control.

The 60 lbs N/acre rate treatment indicated an advantage for plant density and plant height compared to the nonfertilized control treatment. The 50 lbs P/acre rate and the 100 lbs P/acre rate treatments indicated an advantage for plant density compared to the nonfertilized control treatment, but the plant heights were about the same on the fertilized treatments as on the nonfertilized control treatment. The 100 lbs P/acre rate treatment was double the 50 lbs P/acre rate

treatment, but the advantage for the 100 lbs P/acre rate was only 44% greater than the advantage for the 50 lbs P/acre rate. The 30 lbs N and 30 lbs P/acre rate and the 60 lbs N and 60 lbs P/acre rate treatments indicated an advantage for plant density and plant height compared to the nonfertilized control treatment. The 60 lbs N and 60 lbs P/acre rate treatment was double the 30 lbs N and 30 lbs P/acre rate treatment, but the advantage for the 60 lbs N and 60 lbs P/acre rate treatment was only 10% greater than the advantage for the 30 lbs N and 30 lbs P/acre rate. The lowest fertilizer rate that indicated an advantage for both plant density and plant height was the 30 lbs N and 30 lbs P/acre rate.

Conclusion

The alfalfa interseeding fertilization-rate techniques trials evaluated both the benefits from nitrogen and phosphate fertilizer on alfalfa plant establishment and the effects on aboveground growth from changes in fertilizer rates. Both nitrogen and phosphate fertilizers can help improve interseeded alfalfa plant growth as long as the fertilizer is not in direct contact with the seed. These trials indicate that low rates, around 30 lbs N and 30 lbs P/acre, would be sufficient to benefit alfalfa plant density and plant height and enhance alfalfa stand establishment (figures 1 and 2).

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Table 1. Alfalfa plant density per meter of row on nitrogen (N) fertilizer treatments for the fertilization-rate trial I.

Fertilizer Treatment	1 st year 1985	2 nd year 1986	3 rd year 1987	4 th year 1988	Mean of growing seasons after 1 st year
15 Apr 85					
0 lbs N/ac	8.25a	0.37b	0.38b	0.13b	0.29b
60 lbs N/ac	17.49a	2.97a	1.09a	0.69a	1.58ab
% of 0 lbs N/ac	212.00	802.70	286.84	530.77	544.83
15 May 85					
0 lbs N/ac	9.93a	0.07c	0.08c	0.03c	0.06c
60 lbs N/ac	14.37a	0.70b	0.28bc	0.16bc	0.38ab
% of 0 lbs N/ac	144.71	1000.00	350.00	533.33	633.33
19 Nov 84					
0 lbs N/ac	4.98a	0.44b	0.22bc	0.15bc	0.27b
60 lbs N/ac	9.13a	2.32ab	1.26a	0.68a	1.42a
% of 0 lbs N/ac	183.33	527.27	572.73	453.33	525.93

Means in the same column and followed by the same letter are not significantly different ($P < 0.05$).

Table 2. Alfalfa plant height (inches) on nitrogen (N) fertilizer treatments for the fertilization-rate trial I.

Fertilizer Treatment	1 st year 1985	2 nd year 1986	3 rd year 1987	4 th year 1988	Mean of growing seasons after 1 st year
15 Apr 85					
0 lbs N/ac	0.95b	6.15ab	11.04ab	7.59a	8.26a
60 lbs N/ac	1.52ab	5.93ab	12.55a	6.92a	8.47a
% of 0 lbs N/ac	160.00	96.42	113.68	91.17	102.54
15 May 85					
0 lbs N/ac	0.80b	2.20c	8.31ab	7.36a	5.96a
60 lbs N/ac	1.10b	4.01b	11.90ab	4.91a	6.94a
% of 0 lbs N/ac	137.50	182.27	143.20	66.71	116.44
19 Nov 84					
0 lbs N/ac	1.54b	6.95ab	10.61ab	6.68a	8.08a
60 lbs N/ac	2.23a	6.65ab	10.71ab	6.21a	7.86a
% of 0 lbs N/ac	144.81	95.68	100.94	92.96	97.28

Means in the same column and followed by the same letter are not significantly different ($P < 0.05$).

Table 3. Alfalfa plant density per meter of row on phosphate (P₂O₅) fertilizer treatments for the fertilization-rate trial I.

Fertilizer Treatment	1 st year 1985	2 nd year 1986	3 rd year 1987	4 th year 1988	Mean of growing seasons after 1 st year
15 Apr 85					
0 lbs P/ac	8.25a	0.37b	0.38b	0.13b	0.29a
50 lbs P/ac	9.24a	0.52bc	0.25bc	0.13b	0.30a
% of 0 lbs P/ac	112.00	140.54	65.79	100.00	103.45
100 lbs P/ac	9.52a	0.61b	0.22bc	0.16b	0.33a
% of 0 lbs P/ac	115.39	164.86	57.89	123.08	113.79
15 May 85					
0 lbs P/ac	9.93a	0.07c	0.08c	0.03c	0.06b
50 lbs P/ac	8.05a	0.07c	0.08c	0.08b	0.08b
% of 0 lbs P/ac	81.07	100.00	100.00	266.67	133.33
100 lbs P/ac	8.29a	0.25bc	0.17bc	0.10b	0.17ab
% of 0 lbs P/ac	83.48	357.14	212.50	333.33	283.33
19 Nov 84					
0 lbs P/ac	4.98a	0.44b	0.22bc	0.15bc	0.27a
50 lbs P/ac	5.25a	0.57bc	0.35b	0.30a	0.41a
% of 0 lbs P/ac	105.42	129.55	159.09	200.00	151.85
100 lbs P/ac	5.31a	0.81bc	0.23bc	0.28a	0.44a
% of 0 lbs P/ac	106.63	184.09	104.55	186.67	162.96

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 4. Alfalfa plant height (inches) on phosphate (P₂O₅) fertilizer treatments for the fertilization-rate trial I.

Fertilizer Treatment	1 st year 1985	2 nd year 1986	3 rd year 1987	4 th year 1988	Mean of growing seasons after 1 st year
15 Apr 85					
0 lbs P/ac	0.95b	6.15ab	11.04ab	7.59a	8.26a
50 lbs P/ac	1.06b	5.91ab	10.22ab	6.26a	7.46a
% of 0 lbs P/ac	111.58	96.10	92.57	82.48	90.31
100 lbs P/ac	1.32b	7.36a	10.10ab	6.93a	8.13a
% of 0 lbs P/ac	138.95	119.67	91.49	91.30	98.43
15 May 85					
0 lbs P/ac	0.80b	2.20c	8.31ab	7.36a	5.96a
50 lbs P/ac	0.89b	5.32ab	8.08ab	5.48a	6.29a
% of 0 lbs P/ac	111.25	241.82	97.23	74.46	105.54
100 lbs P/ac	1.05b	4.96ab	8.23ab	7.43a	6.87a
% of 0 lbs P/ac	131.25	225.45	99.04	100.95	115.27
19 Nov 84					
0 lbs P/ac	1.54b	6.95ab	10.61ab	6.68a	8.08a
50 lbs P/ac	1.64ab	7.26a	9.53ab	7.03a	7.94a
% of 0 lbs P/ac	106.49	104.46	89.82	105.24	98.27
100 lbs P/ac	1.55ab	6.63a	8.24b	6.62a	7.16a
% of 0 lbs P/ac	100.65	95.40	77.66	99.10	88.61

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 5. Alfalfa plant density per meter of row on nitrogen (N) and phosphate (P₂O₅) fertilizer treatments for the fertilization-rate trial II.

Fertilizer Treatment	1 st year 1986	2 nd year 1987	3 rd year 1988	4 th year 1989	Mean of growing seasons after 1 st year
22 Apr 86					
Ladak					
0 lbs N & P/ac	9.85b	3.27c	3.38c	1.38b	2.68a
30 lbs N & P/ac	16.22ab	5.58b	4.49b	1.95ab	4.01a
% of 0 lbs N & P/ac	164.67	170.64	132.84	141.30	149.63
60 lbs N & P/ac	14.36ab	4.98b	4.91ab	2.44ab	4.11a
% of 0 lbs N & P/ac	145.79	152.29	145.27	176.81	153.36
Travois					
0 lbs N & P/ac	18.56ab	5.09b	4.33b	1.71ab	3.71a
30 lbs N & P/ac	25.80ab	6.26a	4.78b	1.67b	4.24a
% of 0 lbs N & P/ac	139.01	122.99	110.39	97.66	114.29
60 lbs N & P/ac	26.07a	6.76a	5.85a	2.69a	5.10a
% of 0 lbs N & P/ac	140.46	132.81	135.10	157.31	137.47

Means in the same column and followed by the same letter are not significantly different (P<0.05).

Table 6. Alfalfa plant height (inches) on nitrogen (N) and phosphate (P₂O₅) fertilizer treatments for the fertilization-rate trial II.

Fertilizer Treatment	1 st year 1986	2 nd year 1987	3 rd year 1988	4 th year 1989	Mean of growing seasons after 1 st year
22 Apr 86					
Ladak					
0 lbs N & P/ac	3.29a	11.74a	7.55a	7.55a	8.95a
30 lbs N & P/ac	3.45a	12.78a	7.94a	8.10a	9.61a
% of 0 lbs N & P/ac	104.86	108.40	105.17	107.28	107.37
60 lbs N & P/ac	3.94a	13.55a	8.58a	7.58a	9.90a
% of 0 lbs N & P/ac	119.76	115.42	113.64	100.40	110.61
Travois					
0 lbs N & P/ac	2.89a	12.01a	7.86a	7.70a	9.19a
30 lbs N & P/ac	3.42a	12.40a	7.38a	8.02a	9.27a
% of 0 lbs N & P/ac	118.34	103.25	93.89	104.16	100.87
60 lbs N & P/ac	3.46a	12.90a	8.04a	7.96a	9.63a
% of 0 lbs N & P/ac	119.72	107.41	102.29	103.38	104.79

Means in the same column and followed by the same letter are not significantly different (P<0.05).



Fig. 1. Fertilizer added to furrow above the alfalfa seed.



Fig. 2. Furrow with fertilizer.

Literature Cited

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