MT-13F

ANNUAL REPORT

Title: Effect of Boron Fertilization on Alfalfa Production (MT-13F)

Year: 1997

Location: 4 J Farms, east of Ledger, MT.

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Objectives: 1) To predict the response of alfalfa to boron fertilization using soil and/or tissue tests; (2) and prepare a final report at conclusion of the project addressing the above objective.

Procedures: Nine fertilizer treatments and blanket applications of 10 lbs Zn, and 30 lbs K/a were applied to an existing, one year old, alfalfa stand on April 18, 1997. The field plot design was a 3 x 3 factorial (0, 40, and 80 lbs P_2O_5, 0, 1, and 2 lbs B/a) with four replicates. Plot size was 6 x 15 feet. A two-foot wide, flail chopper was used for the first cutting. A three-foot Jari mower was used for cuts two and three. After weighing, plot samples were sub-sampled for nutrient and water analysis. Harvest dates were June 18 for Cut 1 (1/20th bloom), August 5 for Cut 2 (25 % bloom), and September 24 for Cut 3 (1/10th bloom). The plot area was soil sampled prior to fertilizer application. Fertilizer materials were treble super phosphate, potassium chloride, zinc sulfate, and Granubor (14.3 % B). Irrigation water was sampled on July 25. Soil and irrigation water analyses are shown in Table 1.

Results: The yield data are summarized in Table 1. The average yield for three cuttings was 6.1 tons/ac. Even though the P and B treatments were based on the initial soil tests, no response to either P or B was detected. The lack of B response is probably explained by the gradual increase in B from 0.4 ppm, in the plow layer, to 1.1 ppm in the 4 to 5 foot depth.

Plant nutrient analyses are shown in Table 2. Boron fertilization increased B uptake in cuts 1 and 2. Boron also increased P, S, Ca, Mg, and Mn uptake in cut 3, and Zn uptake in cut 2. Phosphorus uptake was unaffected by P fertilization, but P concentration gradually declined from 0.26 to 0.22 % to 0.15 % for cuts 1, 2, and 3, respectively. Zinc concentration declined with the increase in P when measured at cuts 2 and 3. At cut 2, B decreased with increasing P. The P and Zn concentration levels appear to be the only nutrients measured that are near or below what is considered their critical levels. In other words, the site should have responded to P.

A composite soil sample of all the 0, 40 and 80 lbs. P_2O_5/a treatments was taken on October 7. The results were 9.5, 16.9, and 18 ppm for the 0, 40 and 80 lbs. P_2O_5/a treatments, respectively, indicating the P fertilizer was dissolved.

Table 1. The effect of Phosphorus and Boron on irrigated alfalfa quality and yield. The experiment was located east of Ledger, MT. Western Triangle Ag. Research Center, Conrad, MT, 1997.

Entry	Treatment P_2O_5	B	Yield[1] 1st Cut	2nd Cut	3rd Cut	Total
	-----(lb/ac)-----		----------(T/ac)----------			
9	80	2	1.58	2.84	1.85	6.26
6	80	1	1.39	2.70	1.89	5.97
3	80	0	1.62	2.68	1.99	6.29
8	40	2	1.33	2.78	1.82	5.94
5	40	1	1.74	2.66	2.03	6.43
2	40	0	1.47	2.66	1.86	5.99
7	0	2	1.52	2.75	1.85	6.13
4	0	1	1.33	2.89	1.87	6.09
1	0	0	1.62	2.71	1.85	6.18
			Summary Statistics			
Experimental Means			1.51	2.74	1.89	6.14
Error Mean Square			0.027	0.061	0.013	0.151
P-value			0.0175	0.8855	0.1738	0.6641
Standard Error			0.165	0.248	0.113	0.389
Standard Error of the Mean			0.083	0.124	0.056	0.195
C.V. 1: (s/mean)*100			10.93	9.03	5.96	6.34
LSD (0.05)			0.24	NS	NS	NS
			Phosphorus Summary			
80			1.53	2.74	1.91	6.17
40			1.51	2.70	1.91	6.12
0			1.49	2.78	1.85	6.13
LSD (0.05)			NS	NS	NS	NS
			Boron Summary			
2			1.48	2.79	1.84	6.11
1			1.49	2.75	1.93	6.16
0			1.57	2.68	1.90	6.15
LSD (0.05)			NS	NS	NS	NS
Interaction P-value			0.003	0.790	0.146	0.264

[1] Yields based on 12% moisture.
Growing season ppt. = Additional moisture from irrigation = 18.0"
Harvest dates for first, second, and third cuttings = June 18, Aug. 5, and Sept. 24, respectively.

Table 1 Continued.

Soil Tests

O.M. = 2.25%, pH = 8.0

Depth (ft.)	B (ppm)	Cl	NH_4-N	NO_3-N	SO_4-S
		----------lbs/a----------			
0-1	0.35	12.3	13.2	31.7	143.5
1-2	0.38	14.2	7.0	7.8	245.9
2-3	0.42	35.0	15.0	3.3	727.9
3-4	0.78	143.5	7.1	2.6	1293.6
4-5	1.08	410.0	7.6	2.2	4335.2

Element (0-6")	Amount (ppm)
P	13.8
Zn	0.48
Mn	5.85
K	234
Cu	0.9
Fe	6.86
B	0.41

Irrigation Water Analysis

PH = 8.3
EC (mmhos/cm) = 0.65
TDS (mg/L) = 442.0
TSS (mg/L) = 8.0

Element or Ion	Amount (ppm)
B	0.089
Ca	45.0
Cl	4.08
Cu	< 0.01
K	2.8
Mg	34.0
Mn	0.03
Na	38.3
P	0.19
S	45.5
Zn	< 0.01
HCO_3^-	248.0
$CO_c^=$	<1.0

Table 2. Alfalfa nutrient uptake as affected by P and B fertilizer. The experiment was located east of Ledger, MT. Western Triangle Ag. Research Center, Conrad, MT, 1997.

Entry	Treatment P_2O_5	Treatment B	N 1st Cut	N 2nd Cut	N 3rd Cut	P 1st Cut	P 2nd Cut	P 3rd Cut	B 1st Cut	B 2nd Cut	B 3rd Cut
	-----(lb/ac)-----		----------(%)----------			----------(%)----------			----------(ppm)----------		
9	80	2	2.79	2.64	3.10	0.256	0.225	0.194	57.35	49.05	57.05
6	80	1	2.84	2.69	3.07	0.252	0.219	0.155	57.15	50.45	56.50
3	80	0	3.03	2.72	2.94	0.278	0.240	0.141	56.27	48.90	53.60
8	40	2	2.90	2.80	3.09	0.263	0.219	0.150	58.92	56.12	54.45
5	40	1	3.24	2.76	3.07	0.277	0.217	0.147	56.65	52.80	54.62
2	40	0	2.90	2.66	3.09	0.244	0.225	0.153	52.22	50.47	55.17
7	0	2	2.96	2.84	3.09	0.274	0.221	0.171	61.95	56.27	55.82
4	0	1	2.95	2.61	3.05	0.239	0.216	0.146	53.77	52.75	54.62
1	0	0	2.87	2.74	2.91	0.257	0.196	0.127	55.90	52.67	52.67
						Summary Statistics					
Experimental Means			2.94	2.72	3.04	0.2599	0.2197	0.1536	56.69	52.17	54.95
Error Mean Square			0.055	0.018	0.019	4.53E-04	3.92E-04	9.23E-04	6.13	7.72	18.17
P-value			0.3096	0.2923	0.4224	0.1360	0.2646	0.1810	0.0009	0.0047	0.9005
Standard Error			0.234	0.133	0.138	0.02128	0.0198	0.03038	2.48	2.78	4.26
Standard Error of the Mean			0.117	0.067	0.069	0.011	0.010	0.015	1.24	1.39	2.13
C.V. 1: (s/mean)*100			7.98	4.91	4.52	8.19	9.02	19.79	4.37	5.33	7.76
LSD (0.05)			NS	NS	NS	NS	NS	NS	3.61	4.06	NS
						Phosphorus Summary					
80			2.89	2.68	3.03	0.262	0.228	0.163	56.92	49.47	55.72
40			3.01	2.74	3.08	0.261	0.220	0.150	55.93	53.13	54.75
0			2.93	2.73	3.01	0.257	0.211	0.148	57.21	53.90	54.37
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	2.34	NS
						Boron Summary					
2			2.88	2.76	3.09	0.264	0.221	0.171	59.41	53.82	55.77
1			3.01	2.69	3.06	0.256	0.217	0.149	55.86	52.00	55.25
0			2.93	2.70	2.98	0.260	0.220	0.140	54.80	50.68	53.82
LSD (0.05)			NS	NS	NS	NS	NS	0.026	2.09	2.34	NS
Interaction P-value			0.1931	0.1651	0.6793	0.0320	0.2279	0.4241	0.0118	0.2482	0.8532

Table 2 continued.

Entry	Treatment P_2O_5	B	Ca 1st Cut	Ca 2nd Cut	Ca 3rd Cut	S 1st Cut	S 2nd Cut	S 3rd Cut	K 1st Cut	K 2nd Cut	K 3rd Cut
	-----(lb/ac)-----		----------(%)----------			----------(%)----------			----------(%)----------		
9	80	2	1.66	1.36	1.43	0.329	0.332	0.331	2.83	2.61	2.60
6	80	1	1.69	1.42	1.14	0.333	0.346	0.278	2.79	2.71	2.59
3	80	0	1.82	1.49	0.94	0.348	0.347	0.220	2.84	2.56	2.51
8	40	2	1.74	1.49	1.11	0.353	0.361	0.261	2.80	2.61	2.66
5	40	1	1.70	1.41	1.08	0.350	0.335	0.267	2.93	2.67	2.51
2	40	0	1.56	1.39	1.13	0.309	0.339	0.261	2.89	2.77	2.67
7	0	2	1.78	1.54	1.35	0.370	0.366	0.328	2.99	2.62	2.64
4	0	1	1.64	1.56	1.21	0.313	0.352	0.286	2.68	2.52	2.54
1	0	0	1.69	1.43	0.95	0.339	0.344	0.233	3.00	2.72	2.60
						Summary Statistics					
Experimental Means			1.70	1.45	1.15	0.338	0.347	0.274	2.86	2.64	2.59
Error Mean Square			0.017	0.022	0.073	8.09E-04	1.47E-03	4.32E-03	0.037	0.049	0.026
P-value			0.2679	0.5767	0.2208	0.1130	0.9336	0.2857	0.3825	0.8106	0.7528
Standard Error			0.132	0.149	0.270	0.028	0.038	0.066	0.191	0.222	0.160
Standard Error of the Mean			0.066	0.075	0.135	0.014	0.019	0.033	0.096	0.111	0.080
C.V. 1: (s/mean)*100			7.76	10.26	23.54	8.41	11.04	24.01	6.68	8.41	6.19
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	NS	NS
			Phosphorus Summary								
80			1.72	1.42	1.17	0.336	0.342	0.276	2.82	2.63	2.56
40			1.67	1.43	1.11	0.337	0.345	0.263	2.87	2.68	2.61
0			1.70	1.51	1.17	0.341	0.354	0.282	2.89	2.62	2.59
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	NS	NS
						Boron Summary					
2			1.72	1.47	1.30	0.350	0.353	0.307	2.87	2.61	2.63
1			1.68	1.46	1.14	0.332	0.344	0.277	2.80	2.63	2.54
0			1.69	1.43	1.01	0.332	0.343	0.238	2.91	2.68	2.59
LSD (0.05)			NS	NS	0.23	NS	NS	0.055	NS	NS	NS
Interaction P-value			0.0949	0.4475	0.3831	0.0461	0.7994	0.5194	0.2227	0.5496	0.6493

Table 2 continued.

Entry	Treatment P_2O_5	Treatment B	Cu 1st Cut	Cu 2nd Cut	Cu 3rd Cut	Fe 1st Cut	Fe 2nd Cut	Fe 3rd Cut	Zn 1st Cut	Zn 2nd Cut	Zn 3rd Cut
	-----(lb/ac)-----		----------(ppm)----------			----------(ppm)----------			----------(ppm)----------		
9	80	2	6.69	6.09	6.91	102.0	70.40	71.05	15.07	14.15	14.32
6	80	1	6.65	6.64	6.86	117.3	79.10	59.60	17.55	14.85	15.32
3	80	0	6.43	6.12	6.77	103.1	75.55	44.65	17.60	13.97	14.87
8	40	2	6.81	6.91	7.05	137.6	74.50	50.50	16.40	15.88	14.97
5	40	1	6.65	6.47	7.22	138.8	72.62	55.67	17.65	14.57	15.00
2	40	0	6.48	6.62	6.90	99.10	73.70	54.72	17.42	14.85	14.22
7	0	2	6.80	7.12	7.38	124.6	82.85	66.67	18.77	17.35	16.82
4	0	1	6.24	6.33	7.25	157.0	75.02	61.20	16.15	14.82	16.45
1	0	0	6.45	6.80	6.94	97.97	72.55	50.32	16.20	14.80	15.62
						Summary Statistics					
Experimental Means			6.58	6.57	7.03	119.7	75.14	57.16	16.98	15.03	15.29
Error Mean Square			0.191	0.367	0.268	2333	88.19	278.30	4.33	1.00	1.31
P-value			0.6554	0.2733	0.7346	0.6316	0.7348	0.4555	0.3761	0.0030	0.0474
Standard Error			0.437	0.606	0.518	48.30	9.39	16.68	2.08	1.00	1.14
Standard Error of the Mean			0.219	0.303	0.259	24.15	4.70	8.34	1.04	0.500	0.571
C.V. 1: (s/mean)*100			6.65	9.22	7.37	40.35	12.50	29.19	12.26	6.65	7.47
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	1.46	NS
						Phosphorus Summary					
80			6.59	6.28	6.84	107.5	75.02	58.43	16.74	14.32	14.84
40			6.65	6.66	7.05	125.2	73.61	53.63	17.16	15.10	14.73
0			6.50	6.75	7.19	126.5	76.81	59.40	17.04	15.66	16.30
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	0.84	0.96
						Boron Summary					
2			6.76	6.71	7.11	121.4	75.92	62.74	16.75	15.79	15.37
1			6.51	6.48	7.11	137.7	75.58	58.83	17.12	14.75	15.59
0			6.45	6.51	6.87	100.0	73.93	49.90	17.07	14.54	14.91
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	0.84	NS
Interaction P-value			0.7645	0.2606	0.9505	0.8534	0.4107	0.4918	0.1054	0.0398	0.6008

Table 2 continued.

Entry	Treatment P_2O_5	Treatment B	Mg 1st Cut	Mg 2nd Cut	Mg 3rd Cut	Mn 1st Cut	Mn 2nd Cut	Mn 3rd Cut	Na 1st Cut	Na 2nd Cut	Na 3rd Cut
	-----(lb/ac)-----		----------(%)----------			----------(ppm)----------			----------(ppm)----------		
9	80	2	0.467	0.311	0.283	27.73	21.75	22.43	997.8	764.5	1320.0
6	80	1	0.442	0.325	0.215	29.13	20.60	18.13	1009.0	940.0	1063.0
3	80	0	0.472	0.332	0.194	30.28	22.98	14.28	1003.0	900.3	1279.0
8	40	2	0.477	0.340	0.222	30.13	21.80	16.95	961.3	988.3	1277.0
5	40	1	0.459	0.322	0.215	30.70	21.23	17.18	824.0	948.3	1180.0
2	40	0	0.432	0.312	0.216	26.33	21.95	17.35	958.8	786.8	1130.0
7	0	2	0.470	0.321	0.259	32.65	25.08	22.05	939.8	812.3	1358.0
4	0	1	0.445	0.333	0.224	27.03	22.45	17.13	998.5	1125.0	1265.0
1	0	0	0.449	0.313	0.190	27.85	19.78	14.10	869.3	1005.0	1283.0
						Summary Statistics					
Experimental Means			0.457	0.323	0.224	29.09	21.96	17.73	951.1	918.9	1239.0
Error Mean Square			2.34E-03	1.08E-03	2.38E-03	10.08	10.82	17.95	3.85E+04	4.55E+04	1.01E+05
P-value			0.8981	0.9108	0.2250	0.1658	0.5761	0.1113	0.8883	0.3406	0.9313
Standard Error			0.048	0.033	0.049	3.18	3.29	4.24	196.3	213.3	318.3
Standard Error of the Mean			0.024	0.016	0.024	1.59	1.64	2.12	98.15	106.6	159.2
C.V. 1: (s/mean)*100			10.58	10.15	21.74	10.91	14.98	23.9	20.64	23.21	25.69
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	NS	NS
						Phosphorus Summary					
80			0.460	0.323	0.231	29.04	21.78	18.28	1003.0	868.3	1221.0
40			0.456	0.325	0.218	29.05	21.66	17.16	914.7	907.8	1195.0
0			0.455	0.322	0.224	29.18	22.43	17.76	935.8	980.8	1302.0
LSD (0.05)			NS	NS	NS	NS	NS	NS	NS	NS	NS
						Boron Summary					
2			0.471	0.324	0.254	30.17	22.88	20.48	966.3	855.0	1318.0
1			0.449	0.327	0.218	28.95	21.43	17.48	943.7	1004.0	1169.0
0			0.451	0.319	0.200	28.15	21.57	15.24	943.5	897.4	1231.0
LSD (0.05)			NS	NS	0.041	NS	NS	3.57	NS	NS	NS
Interaction P-value			0.7937	0.5968	0.4954	0.0572	0.3238	0.2822	0.7273	0.3423	0.9338