

**ALFALFA
RESPONSE
TO
MOLYBDENUM
ON TATUM SOIL**

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ALFALFA RESPONSE TO MOLYBDENUM ON TATUM SOIL

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Crop response to the trace element molybdenum has been reported by investigators for a number of years. Legumes have been the principal plants benefited, and the fixation of atmospheric nitrogen through symbiotic bacterial activity is considered the physiological process involved. Bacterial welfare, to a degree, is affected by soil pH and it is logical that response to molybdenum would vary with liming and soil pH. Molybdenum also increases in chemical availability as the pH increases, in contrast to other trace elements.

Procedure

The experiment was conducted on Tatum silt loam near Orange, Virginia in 1963-1965. The objective was to determine the response of alfalfa to molybdenum at different pH levels of the soil.

Alfalfa was seeded in 1963 on plots where an extensive range of soil pH values had been previously established by different rates of liming in random blocks. Molybdenum was applied to one half of each plot at the rate of 9 oz. per acre in each year of 1963 and 1964 and 1 oz. in 1965. This quantity is neither necessary nor advisable in ordinary practice (1 to 2 oz. per acre normally suggested) but was used in the experiment to insure a response if such were possible. The alfalfa was well fertilized with phosphorus, potassium and boron. It received 1000 lbs. of 0-14-14 and 20 lbs. of borax per acre in the spring of each cutting year.

Results

The alfalfa was cut 9 times during the experiment, once in 1963 and 4 times each in 1964 and 1965. Rainfall was inadequate in all the harvest years and yields are not high as would be expected for the rate of fertilization used. Soil tests for the different pH levels are presented in Table 1. In most plots the fertility would be classed as medium.

The yield response to molybdenum was most pronounced at the lower pH levels of the soil (Tables 2, 3, and 4). At pH levels of approximately 6.2 and above no response was obtained. Molybdenum had its greatest beneficial effect at pH levels between 5.1 and 6.2, but the lowest pH levels were too low for vigorous alfalfa growth, even with molybdenum. The 1964 and 1965 yields were more representative of normal yields than 1963, since that was the year of establishment. Figure 1 presents in graphic form the total 3-year yields obtained with and without molybdenum. The percentage yield increases from molybdenum at pH levels of 5.1, 5.3, 5.7, 6.0, and 6.5 were 482, 141, 25, 6, and -1.5 respectively. Whenever yield response was obtained to molybdenum it was characterized by a greener color and a better survival of the alfalfa stand.

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A typical cutting of the alfalfa in 1964 was analyzed to determine if molybdenum was affecting the composition of the plants. The results, presented in Table 5, indicate that the nitrogen content of the alfalfa was increased by molybdenum. Relative to pH, nitrogen content due to molybdenum followed a trend similar to that of yield increase. Nitrogen content decreased with increasing pH. This showed as 15, 10, 10, 5, and 0% at pH values of 5.1, 5.3, 5.7, 6.0 and 6.5, respectively. A higher nitrogen content of the alfalfa receiving molybdenum agrees with data supporting the involvement of molybdenum in nitrogen fixation by symbiotic bacteria associated with legumes. It should be noted that the pH level also influenced the nitrogen level in the plant, being highest at the highest pH level. No important differences in calcium, magnesium, potassium, or phosphorus content of the forage were found.

Summary

So far as is known, the first authenticated field crop response to applied molybdenum in Virginia was obtained in 1963-1965, near Orange on Tatum silt loam. Molybdenum increased alfalfa yields 482, 141, 25, and 6% at pH levels of 5.0, 5.3, 5.7, and 6.0, respectively. No increase was obtained above approximately pH 6.2. The nitrogen content of the alfalfa was also increased by molybdenum. As with yield, the largest increases in nitrogen content occurred at the lowest pH levels with no increase at all at pH levels of approximately 6.2 or above. It is concluded that sufficient molybdenum was present for normal alfalfa growth and symbiotic bacterial action, but was not sufficiently soluble at low pH levels to satisfy these requirements. These data in no way suggest that molybdenum can be used as a supplement to, or, in place of, a sound liming program.

Table 1. Soil tests in 1963 on Tatum silt loam from plots in experiment on alfalfa response to molybdenum.

Ground limestone*	Replication	Soil pH	Organic Matter	CaO	MgO	P ₂ O ₅	K ₂ O
tons/acre			percent	----pounds per acre----			
0	1	5.2	2.0	285	356	37	261
	2	4.9	2.4	200	128	49	373
	3	5.1	2.3	210	439	47	310
	4	5.0	2.2	170	200	49	286
	Average	5.1	2.2	216	281	46	308
1	1	5.3	2.4	315	347	29	318
	2	5.2	2.3	180	200	37	268
	3	5.4	2.1	160	365	43	286
	4	5.4	2.2	180	200	33	298
	Average	5.3	2.3	209	278	36	293
2	1	5.8	1.9	1075	329	29	536
	2	6.0	2.2	535	374	25	268
	3	5.6	2.1	285	383	33	215
	4	5.5	2.1	499	347	21	367
	Average	5.7	2.1	599	358	27	347
4	1	6.5	2.0	1100	439	27	240
	2	5.9	2.2	427	365	29	454
	3	5.9	2.2	455	217	19	252
	4	5.8	2.8	517	403	31	227
	Average	6.0	2.3	625	356	27	293
8	1	6.2	2.2	345	421	31	227
	2	6.7	1.6	625	430	27	612
	3	6.6	2.2	499	188	39	157
	4	6.5	2.5	373	439	21	208
	Average	6.5	2.1	461	370	30	301

*Limestone applied in 1954.

Table 2. 1963 alfalfa yield from 1 cutting with and without molybdenum at 5 levels of soil pH on Tatum silt loam.

Soil pH	No molybdenum	Molybdenum
	pounds per acre, 12% moisture*	
5.1	343	632
5.3	563	1028
5.7	895	1140
6.0	1072	1090
6.5	1215	1271

*Each value is the average of 4 replications.

Table 3. 1964 alfalfa yield from 4 cuttings with and without molybdenum at 5 levels of soil pH on Tatum silt loam.

Soil pH	No molybdenum	Molybdenum
	pounds per acre, 12% moisture*	
5.1	136	2261
5.3	1899	4058
5.7	3968	5242
6.0	4389	4772
6.5	4611	4652

*Each value is the average of 4 replications.

Table 4. 1965 alfalfa yields from 4 cuttings with and without molybdenum at 5 levels of soil pH on Tatum silt loam.

Soil pH	No molybdenum	Molybdenum
	pounds per acre, 12% moisture*	
5.1	179	903
5.3	1639	4778
5.7	4846	5697
6.0	5703	5960
6.5	5666	5372

*Each value is the average of 4 replications.

Table 5. Chemical analyses of alfalfa from 2nd cutting in 1964 on Tatum silt loam with and without applied molybdenum.

Soil pH	No Molybdenum					Molybdenum				
	N	P	K	Ca	Mg	N	P	K	Ca	Mg
percent of dry weight*										
5.1	2.44	0.25	2.40	1.05	0.24	2.80	0.23	2.67	1.01	0.22
5.3	2.61	0.25	2.76	1.05	0.18	2.88	0.23	2.75	1.01	0.19
5.7	2.59	0.23	2.49	1.14	0.26	2.87	0.21	2.68	1.11	0.18
6.0	2.76	0.21	2.37	1.29	0.30	2.91	0.21	2.62	1.19	0.24
6.5	2.90	0.23	2.45	1.09	0.27	2.90	0.23	2.18	1.18	0.33

*Each value is the average of 4 replications.

Figure 1. Total 3 year alfalfa yields with and without molybdenum.

