Yield Increases from Nitrogen on Native Range in Southern British Columbia[1]

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Highlight

Response of native range to nitrogen fertilizer has been variable in the province of British Columbia, Canada. Yields have been approximately doubled at many sites reported, but at others virtually no increase has been obtained. It is therefore of interest to report results at 9 additional locations. Average yields from 7 locations over periods from 1 to 4 years from a single fertilizer application were 507 lb/acre without fertilizer, 701 lb from 60 lb/acre N and 880 lb from 240 lb/acre N. Yield increases from 60 lb N averaged from 4 locations declined from 68% in the first year to 35% in the second, 14% in the third, and 6% in the fourth. However, yield increases from 240 lb N remained high with 73% increase the first year, 58% in the second, 92% in the third, and 101% in the fourth year. Cost of the increased yield ranged from $6.40 to $98.00/ton.

The amount of spring and fall grazing available is usually the limiting factor in the size of ranch operation in British Columbia according to Tisdale et al. (1954) and Vrooman et al. (1946). The productivity of the 3 million acres of these lower grasslands is a key factor in overall ranch productivity and profit, since greater stocking capacity on them can make possible greater utilization of the 17 million acres of the higher timber ranges at present not fully utilized. Therefore, methods of increasing the productivity of spring and fall ranges are critical.

Native range in the U.S. Pacific Northwest has been shown to respond to nitrogen fertilization (Mader, 1957; Rogler and Lorenz, 1957; Sneva et al., 1958). In the nearby Canadian province of British Columbia, considerably increased yield has been obtained at 5 locations (Mason and Miltimore, 1959; Mason and Miltimore, 1964; Hubbard and Mason, 1967) but virtually no increase has been obtained at 3 other locations (Hubbard and Mason, 1967). More information from a wider range of sites would be useful in assessing the value of nitrogen fertilizer. In the present paper, response of native range to nitrogen fertilizer at 9 additional locations is reported.

Experimental Area and Procedure

Nine study sites, including 7 in one series and 2 separate experiments, were located in the Okanagan–Bridesville–Similkameen area of southern British Columbia, Canada, encompassing an area approximately 50 miles from north to south and 90 miles from east to west. Of the 7 experiments in one series, 3 were located on stands dominated by beardless wheatgrass, *Agropyron inerme*, and 4 on mixed stands of beardless wheatgrass and needle-and-thread, *Stipa comata*. Of the 2 separate experiments, one was on a mixed stand of needle-and-thread and downy brome, *Bromus tectorum*, and the other was on Kentucky bluegrass, *Poa pratensis*.

The condition of all the sites either dominated by or containing mixed stands of beardless wheatgrass was good. The site containing needle-and-thread and downy brome was in very good condition, and had not been grazed for many years. The Kentucky bluegrass stand also was in very good condition.

The 9 study sites varied considerably in elevation and therefore in climate. The climate at the nearest weather station to the sites studied for all the elevations involved is presented (Table 1). Each study site may be paired with the weather station on the basis of comparable elevation. Yearly data is presented for the study period, 1959–1965.

Plots 4 × 20 ft were laid out in a randomized block field plot design with 4 replications. A single application of ammonium nitrate (33-0-0) was

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Table 1. Climate at stations in the experimental area.

Station	Altitude (ft.)	Annual mean temp. (F)	Average annual precip. (inches)	Annual precipitation (inches) 1959	1960	1961	1962	1963	1964	1965
Keremeos	1410	49	10.16	11.26	15.70	9.42	9.56	11.02	10.36	10.43
Summerland	1491	48	11.45	11.16	7.60	11.94	10.95	15.02	12.24	11.17
Greenwood	2490	43	17.12	20.09	18.16	18.06	17.21	15.72	19.03	20.28
Carmi	4084	39	22.21	24.49	17.73	20.66	25.03	22.69	25.30	20.31

broadcast with a 4-ft Gandy spreader in October with the exception of the Keremeos and Kaleden experiments which were fertilized in April. Dry matter production was measured by harvesting a single strip 36 inches wide from each plot with a sickle-bar mower when the plants were mature but before seed-fall. Total harvest from each plot was oven-dried at 95 C.

Results

Dry matter yields were increased substantially by nitrogen applications in the 7 series experiments (Table 2). Average first year yields from 7 experiments were 443 lb/acre dry matter from the check, 857 from the 60-lb N application, and 902 from the 240-lb application. In terms of percentage increase, the response from the 60-lb N application was 93% and from the 240-lb N application 103%.

The average second year yields in data from 5 experiments carried on for more than 1 year were 415 lb/acre from the check, 554 lb/acre from the 60-lb rate, and 681 lb/acre from the 240-lb rate. In terms of percentage increase, these are 33% at the 60-lb rate and 64% at the 240-lb rate.

A yearly decline in production during 4 successive years of harvest was evident due to a diminishing supply of nitrogen following initial application (Table 3). The 240-lb level produced much longer lasting results than the 60-lb level. The response to the 60-lb rate was 168% of the check the first year, 134% the second year, 114% the third year, and in the fourth year 106%. The response to the 240-lb rate was 173% of the check in the first year, 158% in the second year, 192% in the third year, and in the fourth year 201%.

On the needle-and-thread—Sandberg bluegrass

Table 2. Yield of range grass fertilized with nitrogen at seven locations in southern British Columbia series experiments.

Location	Elevation (ft)	Year	Pounds actual N per acre 0	60	240	F test
1. Rock Creek	2500	1962	413	945	1188	* *
		1963	102	189	211	N.S.
		1964	276	397	822	* *
2. Rock Creek	2500	1962	339	575	463	* *
		1963	187	208	162	N.S.
		1964	245	311	350	N.S.
		1965	123	141	106	N.S.
3. Bridesville	3500	1962	396	656	585	* *
4. Bridesville	3750	1962	1035	1737	1865	* *
		1963	878	1124	1524	*
		1964	1570	1821	2396	N.S.
		1965	1295	1299	1624	N.S.
5. Bridesville	4500	1962	542	1193	1189	* *
		1963	602	672	738	N.S.
		1964	1054	1060	1419	N.S.
		1965	597	570	809	N.S.
6. Keremeos	1100	1962	167	194	268	* *
		1963	308	576	768	* *
		1964	173	197	586	* *
		1965	144	167	646	* *
7. Kaleden	1400	1962	211	698	765	* *
General Mean			507	701	880	

Table 3. Yield averages of 1st, 2nd, 3rd, and 4th years, expressed as percent of check yields from locations 2, 4, 5, and 6 in response to nitrogen fertilizer.

Year	Location	Pounds of actual N per acre 0	60	240
First year	2	100	169	136
	4	100	168	180
	5	100	219	216
	6	100	116	160
	Ave.	100	168	173
Second year	2	100	112	87
	4	100	128	174
	5	100	112	123
	6	100	186	249
	Ave.	100	134	158
Third year	2	100	127	143
	4	100	116	152
	5	100	101	135
	6	100	114	340
	Ave.	100	114	192
Fourth year	2	100	114	86
	4	100	100	126
	5	100	96	141
	6	100	116	450
	Ave.	100	106	201

Table 4. Yield of a needle-and-thread and downy brome (lb./acre dry matter) association in response to nitrogen fertilization. Altitude, 1500 ft.

Year	Pounds of actual nitrogen applied Nov. 1958			F test
	0	60	120[1]	
1959	548	985	1048	*
1960	150	295	344	**
1961	894	1679	2690	**
Mean	531	987	1361	

[1] Nitrogen application raised to 450 lb./acre of N in 1959.

association, the check yield was 548 lb/acre in 1959. This was increased 80% by 60 lb N and 84% by 120 lb N. The high nitrogen treatment was increased to 450 lb N in 1960. Growth that year was minimal. The check yield was 150-lb/acre, the 60-lb N treatment increased yield 96%, and the 450-lb N treatment increased yield 130%. However, in 1961 there was good growth with the check yielding 894 lb/acre, the 60-lb N treatment increasing yield 87%, and the 450-lb N treatment increasing yield 200% (Table 4).

On the Kentucky bluegrass stand, yield was increased from 1,252 to 3,080 by 100 lb N in 1959, an increase of 146%. Four years later, in 1962, yield from the single application of fertilizer in 1959 was increased from 566 to 955 lb/acre, an increase of 68% (Table 5).

Table 5. Yield of Kentucky bluegrass (lb./acre dry matter) in response to nitrogen fertilization. Altitude, 3750 ft.

Year of harvest	Pounds of actual N applied		F test
	0	100	
1959	1252	3080	**
1962	566	955	**

Discussion

These data show that the yield of several species of range grass can be markedly increased in the southern area of the British Columbia Interior grasslands by the application of nitrogen fertilizer. Significant increases were obtained at all 9 locations. These results are different from those of Hubbard and Mason (1967) who found no response at 2 locations and only slight response at a third location near Kamloops but a marked response at a fourth location at Summerland.

Nitrogen fertilizer will increase production of considerable areas of the grasslands but there are apparently some locations that do not respond. The non-responsive areas have not been clearly defined, nor have the causal factors for non-response been identified. In view of the wide differences in response to fertilization these factors should be determined. Soil texture may be an important factor and poor range condition could very well be another.

One important factor determining the economic feasibility of range fertilization is the unfertilized yield level. For example, at the lowest unfertilized yield found in these experiments (102 lb/acre) a 60% yield increase results in 61 lb more forage per year. At the highest unfertilized yield found (1,570 lb/acre) a 60% yield increase results in 940 lb more forage per year. The increases over the average 3-year response period would be 183 and 2,820 lb. Cost of the 60 lb of nitrogen is about $9.00 in both cases. The additional yield from fertilization would therefore cost from $98.00 to $6.40 per ton. The values from $6 up to about $20 to 25/ton should give economic returns on most ranches.

When additional forage from fertilization is valued at $20.00/ton, 3 of the 7 sites which were harvested more than once give sufficiently high additional yields that fertilization would pay. If hay were valued at $30.00/ton, 5 of the 7 sites would be economic to fertilize. In addition, the two sites where only one harvest was made gave higher than average responses in the first year which suggests that an even larger number of sites would give an economic response.

Many factors are involved in determining the economics of range fertilization. The cost of hay used in the above calculations is low in relation to actual costs and any increase in the purchase cost of hay makes fertilization more attractive at less responsive sites. The value of feed readily available on the ranch cannot be calculated very accurately but it is an important consideration. In addition, crude protein content of fertilized grass is increased according to Mason and Miltimore (1959) and this is important in fall and winter grazing where the crude protein content of the grass is characteristically low. Seed production was more than doubled from 50 lb of nitrogen according to Miltimore, Mason, and Rogers (1962) and this would help to strengthen and preserve stands where seed is the principal means of reproduction.

In many instances yields of range grass have been doubled by reseeding to grasses with greater yield potential. Such stands respond to nitrogen fertilizer comparably to native stands (Sneva et al., 1958) and hence the overall increases of 57% from 60 lb of nitrogen as reported herein would apply to a much higher unfertilized yield and this would make fertilization economic on a greater number of sites.

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