Responses of Annual Range to Urea Applied at Various Dates
Author(s): Milton B. Jones
Source: *Journal of Range Management*, Vol. 13, No. 4 (Jul., 1960), pp. 188-192
Published by: Allen Press and Society for Range Management
Stable URL: http://www.jstor.org/stable/3894949
Accessed: 08/04/2013 12:41

the pot-culture technique does have promise for providing a rapid evaluation of soil-nutrient deficiencies and of excesses of toxic elements. This is especially true in areas of diversified range soils where little or no soils work has been done.

Summary

Frontier barley and Romaine lettuce were used as indicator plants to evaluate the fertility status of four mountain soils and one cultivated soil by the pot-fertility technique. The study was conducted in a coldframe. Nine fertility treatments were used: lime, manure, micronutrients, $N_0P_3K_1$, $N_2P_3K_0$, $N_2P_0K_1$, $N_2P_3K_1$, $N_2P_3K_1$ + lime, and $N_2P_3K_1$ + lime + micronutrients. A check treatment was also included. In general, the soils tested were deficient in nitrogen, phosphorus, and lime. Increased forage production can be expected if the deficient nutrients are supplied and if other environmental factors of the site are favorable. The indicator species used responded differently to different fertility treatments on different soils. This variation in species response together with environmental differences between coldframe and field conditions, makes it difficult to generalize the results obtained. In spite of these disadvantages, the pot-culture technique does have promise for providing a rapid evaluation of soil deficiencies and toxic excesses.

LITERATURE CITED

ARMIGER, W. H., L. A. DEAN, D. D. MASON AND E. J. KOCH. 1958. Effect of size and type of pot on relative precision, yield, and nutrient uptake in greenhouse fertilizer experiments. Agron. Jour. 50(5):244-247.

BEAR, FIRMAN E. 1957. Toxic elements in soil. *In* Soil 1957 Yearbook of Agriculture, U. S. Government Printing Office, Washington, D. C. pp. 165-171.

BILLINGS, W. D. 1950. Vegetation and plant growth as affected by chemically altered rocks in the western Great Basin. Ecology 31(1):62-74.

COLWELL, W. E. 1943. A biological method for determining the relative boron content of soils. Soil Sci. 56:71-94.

DUNCAN, D. B. 1955. Multiple range and multiple F test. Biometrics 11:1-42.

JENNY, H., J. VLAMIS AND W. E. MARTIN. 1950. Greenhouse assay of fertility of California soils. Hilgardia 20(1):1-8.

LAMOTTE CHEMICAL COMPANY. 1952. La Motte Soil Handbook. La Motte Chemical Products Company, Baltimore 4, Maryland.

MONDRZAK-ROSENBERG, G. 1958. The use of a plant indicator for determining the nutrient status (nitrogen, phosphorus, and potassium) of various soils. Ktavim 8(3-4):351-358.

OREGON STATE COLLEGE SOIL TESTING LABORATORY. 1954. Methods of soil and plant analyses. Corvallis, Oregon.

STEPHENSON, R. E. AND C. E. SCHUSTER. 1941. Laboratory, greenhouse, and field methods of studying fertilizer needs. Soil Sci. 52:137-153.

TERMAN, G. L. 1959. Variability in results from greenhouse pot experiments comparing phosphorus rates and sources. Agron. Jour. 51:67-71.

U.S.D.A. SALINITY LABORATORY STAFF. 1954. Diagnosis and improvement of saline and alkali soils. Agriculture Handbook No. 60, U. S. Department of Agriculture. 160 pp.

VANDECAVEYE, S. C. 1948. Biological methods of determining nutrients in soil. *In* Diagnostic Techniques of Soils and Crops. American Potash Institute, Washington, D. C. pp. 199-230.

VLAMIS, J., E. C. STONE AND C. L. YOUNG. 1954. Nutrient status of brushland soils in southern California. Soil Sci. 78(1):51-55.

Responses of Annual Range to Urea Applied at Various Dates[1]

MILTON B. JONES

Assistant Agronomist, University of California, Hopland Field Station, Hopland.

A number of field trials throughout the annual range type in California reported by Martin, et al. (1957), have indicated a marked response to nitrogenous fertilizers. The majority of these tests have produced economical livestock gains. Other workers (Love and Williams, 1956) (Hoglund, et al, 1952) have pointed out that nitrogen fertilization advanced the date of grazing readiness, increased total production and reduced annual fluctuation in forage yield by reducing drought and frost damage.

In all the work cited above the fertilizer was applied in the fall and in the ammonia form. Application of nitrogen was made before the first fall rains in order that it might be readily available to increase early growth rate of the young plants, and was applied in the ammonia form to reduce leaching. Tyler, et al. (1959) pointed out that the efficiency of fall application of ammonia depends upon the rate of nitrification, which is dependent upon environmental conditions, mainly temperature, moisture and the soil type. Rate of nitrification about doubled for every 10° F increase, based on the averages for a number of soils. Where aqua ammonia was added to the soil at the rate of 100 ppm, from 25 to 50 ppm had oxidized to nitrate in eight weeks even at 37° F and over the same period from 50 to 125

[1] *A contribution of the Department of Agronomy, University of California at Davis.*

ppm nitrogen had oxidized at 45° F, which is considered a minimum average winter temperature in many California agricultural areas. Work by Broadbent (1958) with three ammonium fertilizers indicated that rate of nitrification and also the elapsed time required before the maximum rate is attained depends on the ammonia level in the soil.

The downward movement of urea and possible leaching loss are dependent on the rate of hydrolysis to ammonia. Broadbent (1958) reported experimental data from four soils which indicated the equivalent of about 200 pounds per acre of urea nitrogen was hydrolyzed to ammonia in two days, and in two of the soils virtually no urea remained after one day. Conrad (1940) and Conrad and Adams (1940) presented evidence that hydrolysis of urea should be considered catalytic in nature instead of completely microbial. Conrad (1941) also stated that the higher the organic matter content of the soil the more rapid the hydrolysis of urea. Consequently the surface soil is more effective in producting hydrolysis of urea than the subsoil. Urea was not leached from Yolo fine sandy loam at 2° C. Baldwin and Ketcheson (1958) found that leaching of urea into the rooting zone was limited by the rapidity of its conversion to ammonia nitrogen, even at 35° F. Fisher and Parks (1958) indicated that at 10°C about 25 pounds of nitrogen per week were hydrolized and subsequently nitrified when nitrogen was applied at 100 to 200 pounds per acre as urea. Eno and Blue (1957) reported that on an acid sandy soil in Florida the nitrification rate of anyhdrous ammonia was about equal to that of urea, but was greater than that of ammonium sulfate.

From the evidence above it must be concluded that under winter conditions existing on California annual rangelands nitrogen applied as ammonia or urea will be converted into the nitrate form in a matter of a few weeks at the most, and if it is not absorbed by the plants it may be readily leached by excessive rainfall. The purpose of the study reported here was to test the efficiency of nitrogen fertilization by measuring the yield, nitrogen content and nitrogen uptake as affected by date of application of urea.

Procedure

Study plots were located on Sutherlin fine sandy loam (Gowans 1959) at an elevation of about 1400 feet above sea level at the University of California's Hopland Field Station in south eastern Mendocino County. Fertilizer was broadcast at six different dates during each of three years, at about the middle of the following months: September, November, December, January, February, and March. The fertilizer treatments were (1) Check, (2) urea, and (3) urea with treble superphosphate. Nitrogen was applied at the rate of 50 pounds per acre the first two years and 75 pounds per acre the third year. Phosphorus was applied at the rate of 75 pounds P_2O_5 as treble superphosphate. A factorial design was used having four replications. The first year individual plot size was seven by thirty feet. The second year individual plots were split in half to seven by fifteen feet in size. One half received no fertilizer so that carry over could be measured, and the other half was fertilized to measure the effect of reapplication. Half of each check plot was fertilized to measure the effects on previously unfertilized areas as in the first year. The third year plots which had received fertilizer the first year only were fertilized since no residual effect was measured on these plots by the end of the second year. Forage production was measured by clipping three, one-square foot quadrats from each plot in February and May of each year. Nitrogen determinations were made on forage samples by the Kjeldahl procedure.

Temperature and rainfall data were recorded at the headquarters weather station at the Hopland Field Station. These data do not represent conditions at plot site but indicate approximate conditions and year to year variation at the site of the experiment. Rainfall and temperature varied widely from year to year during the three years of the experiment (Figures 1 and 2). The 1956-57 growing season

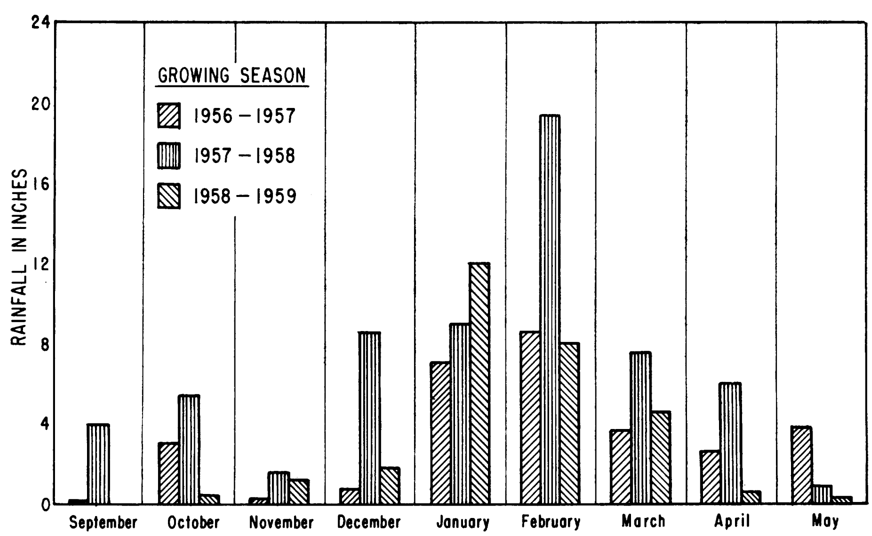

FIGURE 1. Monthly rainfall during the growing seasons of the experiment.

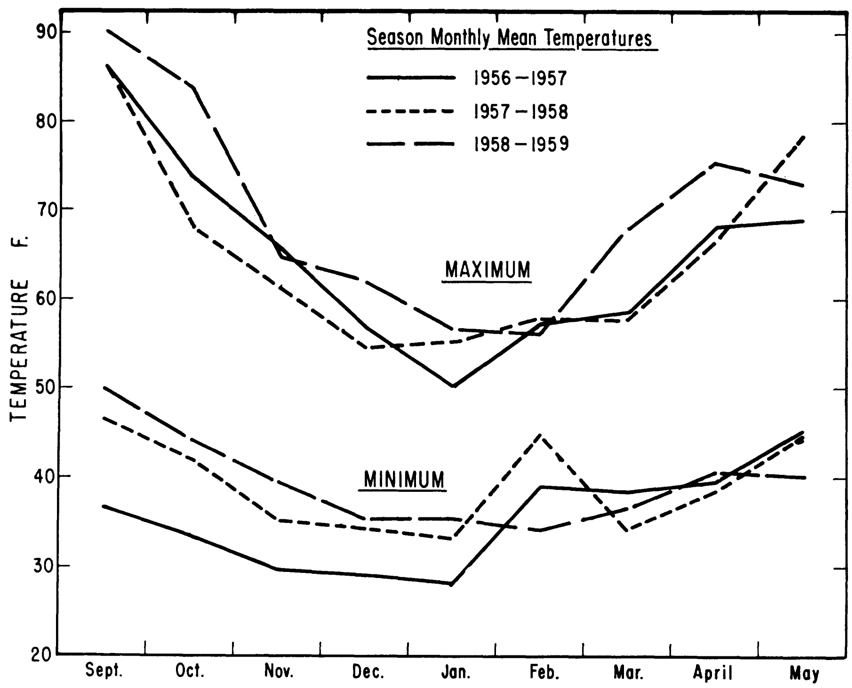

FIGURE 2. Monthly mean maximum and minimum temperatures during the growing seasons of the experiment.

was relatively cool and dry in the fall, and warm and wet in the spring, with total rainfall amounting to 29 inches. The first rains sufficient to germinate plants came in late October 1956. The 1957-58 season began with heavy rain in late September and continued relatively warm and wet through April with rainfall totalling 60 inches. The 1958-59 season was warm throughout. The first rains sufficient to germinate annual plants came in late November. There was a shortage of moisture for January, February and March, and total rainfall for the season was 28 inches.

Principle plant species on the plots were soft chess (*Bromus mollis*), slender wild oats (*Avena barbata*), ripgut (*B. rigidus*), fescue (*Festuca* spp.) broadleaf and narrowleaf filaree (*Erodium botrys* and *E. cicutarium*), annual resident clovers (*Trifolium* spp. and *Lotus* spp.), and lupine (*Lupinus* spp.). The percentage of these species was estimated by the step-point method (Evans and Love, 1957).

Results and Discussion

Forage production in February was increased most by urea applied in September and least by urea applied in January (Table 1). Phosphorus applications with urea did not increase yield over urea alone. The urea applied in November and December gave intermediate yield values. The greater response to the early fall application was consistent for each of the three years.

The nitrogen content of the forage clipped in February was significantly increased by the application of nitrogen fertilizer, and the date the fertilizer was applied also affected the nitrogen content (Table 1). Plots fertilized in December and January had forage with the highest nitrogen content. In comparison, plots fertilized in September were lowest in precent nitrogen. The nitrogen content results were consistent from year to year. Fertilized plants were generally lower in nitrogen content in the wet years than in th dry years. Increased growth during the wet year increased leaching of nitrogen from the soil or changes in botanical composition could have been contributing factors to cause this lower nitrogen percentage in the plants.

Total nitrogen uptake was increased by urea fertilizer, but the date of fertilization did not significantly change the yield of nitrogen in February (Table 1). There was much more total nitrogen taken up by the plants by February during the wet year than the two dry years.

The May yield each year was increased by the application of urea fertilizer and the date at which this fertilizer was applied affected yield (Table 2). The average yield for three years indicated that the September appli-

Table 1. Mean February forage yields, nitrogen content and total nitrogen uptake of plants as affected by urea applied in different months.

Month N was applied	Forage yields	N	N yield
	(Pounds per acre)	(Percent)	(Pounds per acre)
September	2030	2.58	52
November	1920	2.86	55
December	1840	2.90	53
January	1730	2.99	52
Unfertilized	1470	2.06	30
L.S.D. 5% level application dates	140	.17	N.S.
L.S.D. 5% level fertilized vs unfertilized	70	.14	4

The month of application-year interaction was not significant for any of the three factors.

Table 2. May forage yields, nitrogen content and total nitrogen uptake of plants as affected by urea applied in different months during three years.

Month N was applied each year	Year Harvested			Year Harvested			Year Harvested		
	1957	1958	1959	1957	1958	1959	1957	1958	1959
	(Pounds forage per acre)			(Percent N in forage)			(Pounds N per acre)		
September	5450	9180	4900	1.51	.93	.93	84	85	46
November	5840	6630	4250	1.27	1.04	1.03	74	69	44
December	5910	7170	4490	1.16	.98	.98	69	70	44
January	6010	6530	4440	1.34	1.00	1.11	80	65	49
February	6680	6480	4930	1.50	1.01	1.19	100	65	59
March	5250	6620	3670	1.76	1.15	1.31	92	76	48
Unfertilized	4230	4750	3030	1.67	.94	.90	71	45	27
L.S.D. 5% level for dates of application	N.S.	1100	N.S.	.22	.09	.12	13	N.S.	10
L.S.D. 5% level for fertilized vs. unfertilized	460	700	560	.12	.03	.04	7	8	6

The month of application-year interaction was significant at the 5 percent level for yield of forage, and yield of N, but not the N content. The urea-year interaction was significant at the 1 percent level for N content but not for forage yield or nitrogen yield.

cation resulted in the highest yield and March applications gave the lowest, with urea in other months giving intermediate values. However, there was a significant date of application-year interaction indicating that the date urea was applied affected the yield the following May differently each year. In May 1957 and 1959 no significant difference in yield resulted from varying the application date. In May 1958, the year of high rainfall, the highest yield came from plots fertilized the previous September and the low yield came from plots fertilized the previous January, February or March. No increase in yield was measured the second year after fertilization with urea irrespective of application date, and no increase was noted where phosphorus was applied with urea compared to urea alone.

At the May sampling date the March application of urea increased the percentage of nitrogen in the forage consistently each year (Table 2). Applying urea at the other five dates did not appreciably affect the nitrogen content of the forage during the last two years of the experiment, but in the 1956-57 season, plots which received urea in November, December and January had a lower nitrogen content than plots which received no nitrogen fertilizer. The nitrogen content of the forage was significantly higher in 1957 than in 1958 and 1959. This difference between years may have been due to the high percentage of clover in the forage in 1957. Sampling the plots in May 1957 indicated that 30 percent of the forage in the unfertilized treatments was *Trifolium* species. Plots fertilized with urea had significantly less clover on them. Plots fertilized with urea in September, November, December, January, February and March had 16, 12, 6, 11, 12, and 21 percent *Trifolium* respectively in May 1957. In May 1958 and 1959 the percentage of *Trifolium* was very low even on the unfertilized plots. The two latter years were "poor clover years" and urea fertilization did not measurably reduce the clover stand in those years. The percent nitrogen in the forage was not affected by urea fertilization the second season after application.

Applications of urea increased the total yield of nitrogen in forage clipped in May (Table 2). Applying the urea in February gave the highest nitrogen uptake in 1957 and 1959, the two driest years, and applying urea in December gave the lowest uptake of nitrogen during these same two years. In 1958 the wettest year, the date of application produced no significant differences in total nitrogen uptake. The total nitrogen uptake by the plants was not affected by urea fertilization the second season after fertilization. Total nitrogen per acre taken up by plants varied from year to year and date of sampling the forage affected which year appeared best. In February 1958, the season of early fall rains, the plots had more nitrogen per acre than in February 1957 or 1959, but more nitrogen per acre had been produced at the May 1957 sampling than by May 1958 or 59. This difference between years appeared to reflect the high percentage of clover in 1957, and total forage production as well. The high clover percent would account for part of the difference between the February and May clipping dates, since most of the nitrogen fixation by legume bacteria would take place during the warmer spring months. It is evident that little or no nitrogen was added to the forage between February and May of the 1958 and 1959 seasons, the poor clover years. Studies to pursue the relationship between annual clovers and their contribution to soil nitrogen are in progress.

Summary and Conclusions

During one wet year and two dry years urea was applied to different plots at six dates over a seven month period from September to March. Applying urea early in the fall was generally more effective in producing winter feed than late fall applications, but for production of spring feed the date of application made no consistent difference except that March application was too late to produce maximum yields.

At the February sampling date plots fertilized with urea the previous September, November, December, and January yielded forage with a progressively higher nitrogen content as the date of application advanced. At the May sampling date the month of urea application produced no consistent difference in nitrogen content of the forage except that plots fertilized in March produced forage in May with the highest nitrogen content.

Total nitrogen uptake was increased by urea fertilization but the date of application produced no significant difference at the February sampling. At the May sampling date, application of urea in February of the two driest years resulted in the greatest yield of nitrogen per acre. During the wet year there was no significant difference in pounds of nitrogen produced as affected by date of application.

LITERATURE CITED

BALDWIN, C. S. AND J. W. KETCHESON, 1958. Influence of soil texture reaction and temperature on the uptake of nitrogen from three nitrogen fertilizers. Soil. Sci. 38:134-142.

BROADBENT, F. E., K. B. TYLER, AND F. N. HILL, 1958. Nitrification of fertilizers. Calif. Agric. Vol. 12(10):9-14.

BROADBENT, F. E., G. N. HILL, AND K. B. TYLER, 1958. Transformations and movement of urea in soils. Soil Sci. Soc. Amer. Proc. 22:303-307.

CONRAD, J. P., 1940. Hydrolysis of urea in soils by thermolabile catalysis. Soil Sci. 49:253-263.

CONRAD, J. P., AND C. N. ADAMS, 1940. Retention by soils of the nitrogen of urea and some related phenomena. Agron. Jour. 32:48-54.

CONRAD, J. P., 1941. Catalytic activities causing hydrolysis of urea in soils as influenced by several agronomic factors. Soil Sci. Soc. Amer. Proc. 5:193-241.

ENO, C. F., AND W. G. BLUE, 1957. The comparative rate of nitrification of anhydrous ammonia, urea and ammonium sulfate in sandy soils. Soil Sci. Soc. Amer. Proc. 21:392-396.

EVANS, R. A., AND R. M. LOVE, 1957. The step-point method of sampling —a practical tool in range research. Jour. Range Mangt. 10:208-212.

FISHER, W. B., JR., AND W. L. PARKS, 1958. Influence of soil temperature on urea hydrolysis and subsequent nitrification. Soil Sci. Soc. Amer. Proc. 22:247-248.

GOWANS, K. D., 1958. Soil survey of the Hopland Field Station. Calif. Agric. Expt. Sta.

HOGLUND, O. K., H. W. MILLER AND A. L. HAFENRICHTER, 1952. Application of fertilizers to aid conservation on annual forage range. Jour. of Range Mangt. 5:55-61.

LOVE, R. M., AND W. A. WILLIAMS, 1956. Range land development by manipulation of the soil-plant-animal complex in the environments of a Mediterranean-type climate. Proc. Seventh Intern. Grassland Cong. Paper No. 12.

MARTIN, W. E., L. J. BERRY, AND W. A. WILLIAMS, 1957. Range fertilization in a dry year. Fourth Prog. Report, Berkeley, University of Calif. Agric. Ext. Serv., pp. 39.

TYLER, K. B., F. E. BROADBENT, AND G. N. HILL, 1959. Low-temperature effects on nitrification in four California soils. Soil Sci. 87:123-129.

Effect of Selective Grazing by Sheep on the Control of Leafy Spurge (*Euphorbia esula* L.)[1]

A. JOHNSTON AND R. W. PEAKE

Agronomist, and Head, Forage Crops Section, Canada Agriculture Research Station, Lethbridge, Alberta

Perennial noxious weeds are a problem in many areas, one of the most serious being leafy spurge (*Euphorbia esula* L.). Recommendations for the control of leafy spurge involve at least two years of intensive cultivation, the use of selective herbicides, or the use of soil sterilants. Such measures are expensive and may be difficult to apply effectively (Hanson and Rudd, 1933, and Muencher, 1930). There are many infested areas where these control measures cannot be efficiently utilized because of cost or other factors. These are light soil areas where the danger of wind erosion is great, stony lands where farm machinery cannot be successfully used, and native pastures where only a cheap, effective measure can be considered.

The competition provided by a perennial grass sown on leafy spurge-infested areas has been suggested as one means of control (Pavlychenko and Kirk, 1946). This method reduced the density of shoots but did not result in death of the roots. Grazing by sheep has been advocated

[1] *Contribution from the Forage Crops Section, Canada Agriculture Research Station, Lethbridge, Alberta.*