

Rose Clover Yield and Quality

applications of superphosphate increased forage production over 300% and protein content 70% in Placer County trials

Walter H. Johnson, W. A. Williams, and W. E. Martin



Unimproved range west of Lincoln of the same type on which the fertilizer trials were made.

In a study carried out during the 1955-56 season near Lincoln, applications of superphosphate to a stand of rose clover increased forage production from 778 pounds per acre to 3,300 pounds per acre—over 300%—and improved forage quality by increasing the protein content 70%, from 8% up to 14%, and the phosphorus level in feed 66%, from 0.15% to 0.25%.

On December 2, 1955, three rates of

single superphosphate were applied in strips 10' x 87' to a four-year-old stand of rose clover containing a scattering of crimson and sub-clover. Each treatment was repeated six times. The soil was a Placentia sandy loam that had never been fertilized. The plots were harvested by clipping on May 14th—when the rose clover was about a week past full bloom—to determine total forage yield.

Applied at the rate of 300 pounds per acre, single superphosphate gave nearly three times the yield of the control and the 600 and 1,200 pounds per acre rates showed yields about four times that of the untreated area.

Separation of the forage into clovers and nonlegumes showed that the forage increase was due almost entirely to the increased production of the annual legumes. The nonlegumes in this area included both broad leaf filaree, and native annual grasses. The 300-pound rate of superphosphate increased yields of clovers nearly twelve times while the 600-pound rate caused a twenty-fold increase. The 1,200 pound rate of superphosphate, however, caused very little additional increase. The amounts of grasses

Rose clover, one of the new annual clovers for range use, is strikingly responsive to fertilization on many terrace and foothill soils. Establishment of improved clovers—such as rose and subterranean—and fertilization with phosphorus and sulfur, where needed, offer one of the best means of increasing spring range forage production. At the same time high quality dry feed for summer and fall use is produced.

and filaree in the forage were not affected by phosphorus applications.

The fertilizer cost of the extra forage produced amounted to only \$7.29 per ton at the 300-pound rate, \$8.83 at the 600-pound rate and \$16.47 where 1,200 pounds were used. Next year carry-over effects may further reduce this cost.

Single superphosphate contains sulfur in addition to phosphorus but the soil in these trials has not responded to applications of sulfur

Feed value and chemical composition of the clovers and grass fraction of the forage were affected by the fertilization.

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Stand of fertilized rose clover on an improved range.



CLOVER

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The per cent crude protein in the clovers was increased but the grasses and filaree were not affected appreciably. Since the proportion of clover in the forage had been greatly increased by fertilization the per cent crude protein in the entire forage was greatly enhanced by the greater amounts of high protein clovers in the forage mixture. Protein production per acre was increased from 65 pounds per acre to over 400 pounds.

The phosphorus content of both rose clover and the grass and filaree was increased. In the case of rose clover the per cent total phosphorus was nearly doubled. Almost the same increase was observed in the filaree and grass, though the phosphorus content of these species was considerably higher than that of clover. The phosphorus recovered by the forage plants amounted to about 10% to 11% of the added fertilizer phosphorus in the two lower rates and 7% at the highest rate of application. Substantial carry-over effect of added phosphorus may be expected from the higher rates of application, and will be measured during the 1956-57 season.

Plant tissue analysis is commonly used as a means of determining the phosphorus status of crop plants and as a diagnostic technique for determining the need of fertilization. The basic principle of its use is that the chemical composition of plants changes with, and reflects the soil nutrient supply.

The problem in calibrating tissue analysis for rose clover is to establish the composition of plants deficient in phosphorus and the composition of plants known to be adequately supplied. The plant composition at the point where further applications of fertilizer cause no further increases in yield is called the critical level.

Data from this field experiment provide an opportunity of relating phosphorus content to yield performance. The actual yield of clover in this experiment is plotted in the accompanying graph against the phosphorus applications. A smooth curve is obtained showing the yield from the highest rate numerically greater, but not significantly higher than that of the next lowest application. Actually, if the maximum yield from the 1,200-pound superphosphate treatment is taken as 100% the 600-pound rate produced 94% as much clover, the 300-pound rate 56%, and the control, 5%.

Beside the yield curve are plotted the corresponding values of the total phosphorus content of the clover from each rate of fertilizer application.

Unfertilized plants with very low yield contained 0.128% total phosphorus.

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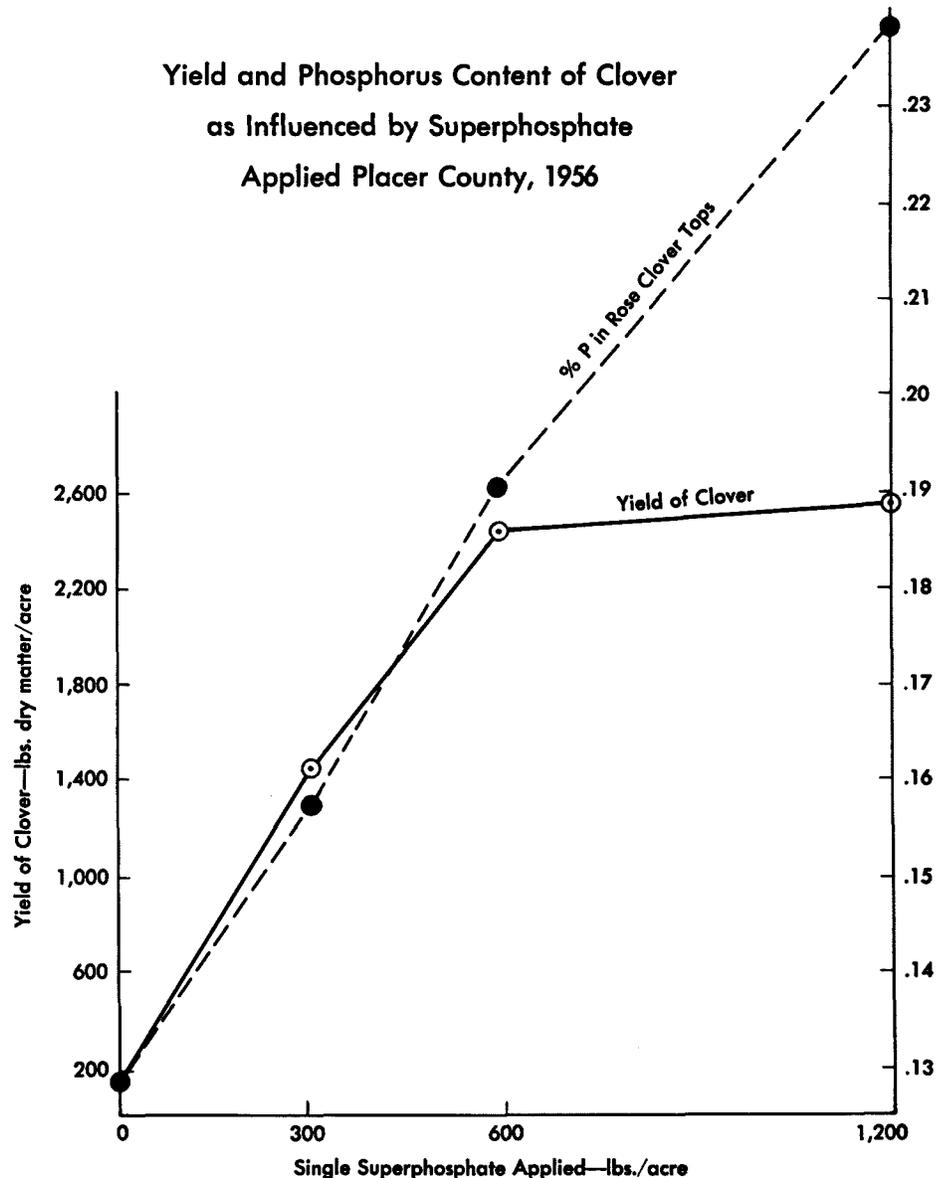
Effect of Superphosphate on Yield of Annual Clover-Grass Range

Fertilizer treatments			Per cent clovers in forage	Yield of forage—dry Wt./Ac			Increase from use of fertilizer lbs./Ac.	Cost per ton of extra forage
lbs. Single super-phos.	Cost per acre	lbs. P ₂ O ₅ per acre		Grasses and filaree lbs./Ac.	Annual clovers lbs./Ac.	Total forage lbs./Ac.		
None	.....	..	20.2%	658	120	778	....	....
300	..... \$5.20	57	65.4	757	1446	2203	1425	\$7.29
600	..... 10.40	114	76.9	720	2414	3133	2355	8.83
1200	..... 20.80	228	77.8	740	2565	3305	2527	16.46
Least significant difference—5% level			16.0	n.s.	654	641	....	....

Effect of Phosphorus Fertilizer on Feed Value of Range Forage

Phosphorus applied as lbs. P ₂ O ₅ /acre	Per cent crude protein			Yield of protein per acre lbs.	Per cent total phosphorus			Recovery of added phosphorus %
	Rose clover %	Grass and filaree %	Whole forage %		Rose clover %	Grass and filaree %	Whole forage %	
None	..... 12.7	7.0	8.4	65	.128	.157	.152	...
57	..... 14.6	7.6	12.4	273	.157	.197	.167	10.0
114	..... 15.9	7.5	13.9	435	.190	.253	.207	10.7
228	..... 16.2	8.2	14.4	476	.238	.308	.253	7.2
L.S.D. 5% ..	.8	1.2	1.5	104	.034	.035	.028	...

Yield and Phosphorus Content of Clover as Influenced by Superphosphate Applied Placer County, 1956



California lemons—the order could provide a mechanism for controlling the supply pressure of juice products. Significant leakages from supply sources outside of California apparently were not fully envisaged. The importation of lemon stock for the domestic manufacture of juice products has tended to increase and—because of the increased value of processing lemons—areas in the United States that had not produced lemons previously became potential suppliers.

As the state marketing order has been operating in most years, a price floor has been established for California lemons processed into juice products. In addition, the order has indirectly afforded price protection to such competing areas as Italy, Florida, and Arizona, where growers enjoy lower lemon-producing cost structures than do most growers in California.

Interlocking Markets

These developments not only bear upon the lemon-juice products market but also on the fresh lemon market because of the consumption competition between the two markets. Further, as juice supplies originating outside California assume increasing volume, there develops a relatively restricted market outlet of value for California lemons for juice products.

The current situation in which the California lemon industry operates—in conjunction with potential developments—emphasizes the importance of considering the fresh and processed markets and their respective marketing orders as closely interrelated dimensions of an essentially single economic market.

The California lemon industry faces the problem of developing an integrated system of operating that is oriented toward the dynamic economic setting in which the industry finds itself.

Sidney Hoos is Professor of Agricultural Economics, University of California, Berkeley.

This series of five articles will be available as a reprint early in 1957, and may be obtained without cost by addressing a request to The Giannini Foundation of Agricultural Economics, 207 Giannini Hall, University of California, Berkeley 4.

ISOTOPES

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made in the center of Australia, as far from the sea as possible and where the situation was not complicated by coal burning industrial operations. There, in cloudless clear weather, the highest activities in these experiments were recorded.

The air was generally calm at night

so the sampling program was changed to separate the catches made in daytime from those at night. The fraction of lead²¹⁰ accumulated during 10 hours or more proved to be in the neighborhood of half of the total activity. The data point to the conclusion that calm weather in inland areas tends to produce high burdens of atmospheric radioactivity. Yet the high proportion of lead²¹⁰ could not be attributed to industrial activities, so it was postulated that its parent isotope—thoron—was delivered continuously from the soils to the atmosphere. To test this assumption, a plot of soil 18" x 40" was dug over and covered by a galvanized iron lid leaving one end open and placing the filter at the other end. The rate of air flow was arranged so the air traveled over the 40" path of loosened soil in a period of two minutes before passing through the filter. If thoron were to escape from the soil, its half life of 54.5 seconds should allow a considerable proportion of it to be converted to polonium²¹⁴—0.14 second half life—and thence to lead²¹⁰. Even though it is assumed that radon also diffused from the soil its half life of 3.8 days would require that most of the gas should pass on through the filter without disintegrating to lead²¹⁰. For comparison a parallel filter was run filtering the same quantity of air from the open atmosphere. It was demonstrated that air in close contact with loosened soil accumulated considerably more activity and the higher proportion of this activity was due to the presence of lead²¹⁰ derived from thorium decay.

Samples of 120 different soils representative of the great soil types of the world were examined and radon was found to be an important component of all of the soil atmospheres.

In the absence of any direct information on health hazard features from natural radioactivity in the atmosphere, a test was conducted with a sheep. On the 20th and 21st of April 1955, two record high counts of radioactive lead²¹⁰—444 and 417 counts per minute—were measured. On the second day of high activity a sheep which had been penned for two weeks close to the site of measurement was slaughtered and its respiratory organs examined.

From the lead isotopes recovered from the sheep's lungs it was concluded that approximately 18% of the lead²¹⁰ inhaled by the sheep during the preceding 24 hours was retained in the respiratory system. Unfortunately this experiment could not show where the balance of the activity had gone. It may have been returned to the atmosphere, or it may have been distributed throughout the body.

The steady intake of lead²¹⁰, which decays to lead²¹⁰ with a 22 year half life, may be retained by the body. Lead²¹⁰

would accumulate and reach half its maximal value in 22 years, 75% in 44 years, and 87½% in 66 years.

The principal findings of this series of investigations are that radioactivity is always present in the atmosphere in the form of decay products of uranium and thorium and that the short-lived thoron—54.5 second half life—and its daughter products assume equal importance with those of radon.

P. R. Stout is Professor of Soil Science, University of California, Berkeley.

C. C. Delwiche is Professor of Plant Biochemistry, University of California, Berkeley.

METABOLITES

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soak period, storage, and growth in soil after treatment are currently under study. The multiple effects of the gibberellins on dormancy, growth, flowering, and fruiting suggest a critical study of their effects on dormancy of pome fruit seeds as well as on dormancy, growth, fruit set and development of pomological crops.

Although the results of these studies are highly suggestive, the practical significance of the gibberellins as agricultural chemicals requires extensive evaluation.

Lawrence Rappaport is Junior Olericulturist in Vegetable Crops, University of California, Davis.

C. A. West, B. O. Phinney and Anton Lang of the University of California, Los Angeles, and S. H. Wittwer and M. J. Bukovac of Michigan State University conducted the additional research on gibberellins referred to in the above article.

Dr. F. D. Stodola, Northern Utilization Research Branch, USDA, Peoria, Illinois, supplied the gibberellins used in these studies.

The above progress report is based on Project 1175 D.

CLOVER

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Plants receiving 300 pounds of superphosphate produced twelve times as much clover and contained 0.157% phosphorus. They were clearly deficient since more applied phosphorus gave a large additional yield increase.

Clover from the 600-pound treatment produced 94% of the maximum yield and contained 0.190% total phosphorus. Further application of fertilizer in the 1,200-pound treatment caused no significant increase in yield, though phosphorus content did increase.

At the control and at the low rates of application the phosphorus content curve follows the yield increase. The yield approached maximum with the 600-pound

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CLOVER

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application, but the composition continued to increase with added phosphorus. This continued increase represents luxury uptake. If the point where yield no longer increases is taken as the critical level, all values below that point are clearly deficient and those above that point represent adequate supply. On this basis 0.19% total phosphorus in the entire clover tops at bloom stage may be taken as the critical value. Plants with composition at or above this level would not be expected to respond to fertilization. Values below this point would indicate need of applying phosphate fertilizer before the next growing season.

Clover leaves were also taken for analysis and showed critical values of 0.177% total phosphorus and 0.098% phosphorus soluble in 2% acetic acid.

The stage of growth at which plants are analyzed is important because phosphorus content declines with advancing maturity. Young succulent plants taken prior to bloom would be expected to show a critical level somewhat higher than those reported.

Walter H. Johnson is Farm Advisor, Placer County, University of California.

W. A. Williams is Assistant Professor of Agronomy, University of California, Davis.

W. E. Martin is Extension Specialist in Soils Fertility, University of California, Berkeley.

LETTUCE

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with several different nitrogenous fertilizer materials and methods of application to determine the relative toxicity of the compounds to lettuce roots. The lettuce variety Great Lakes was used in all tests. Four materials, ammonium sulphate, calcium nitrate, liquid ammoniated ammonium nitrate—containing 28% ammoniacal and 12% nitrate nitrogen—and urea were applied as dilute solutions—10 milligrams per milliliter—to one-month-old plants growing in 6" pots of steam-sterilized Yolo loam soil.

Each material was applied to three groups of five pots each at rates of 80, 160, and 320 pounds of nitrogen per acre. The requisite amounts of the respective solutions were poured on the surface of the soil. One month later the plants were removed from the pots, and the main root was sliced lengthwise and examined for damage. No apparent injury resulted from any of these treatments.

In another greenhouse trial, the same nitrogenous fertilizer materials were applied at the rates of 50 and 100 pounds per acre in the dry or undiluted form to the roots in the bottom of the pots.

This was done by upending the pots, dumping out the mass of soil and plant roots, applying the fertilizer to the exposed plant roots, and returning the soil and plants to the pots. The plants were examined for root injury six days later. All treatments showed severe injury and death of rootlets that had been in direct contact with the fertilizer materials. The ammoniated ammonium nitrate solution also caused pronounced discoloration and injury of the xylem core of the main root at rates of both 50 and 100 pounds per acre.

The experiment was repeated with the same four materials and, in addition, sodium nitrite and concentrated phosphoric acid. Dried chicken manure that had been ground into a powder also was applied in a similar manner, but at higher rates of 2, 4, 8, and 16 tons per acre. Examination of roots to determine the degree of internal damage was made 12 days after the materials were applied.

All materials caused some damage when applied directly to exposed roots. However, ammoniated ammonium nitrate and sodium nitrite were considerably more toxic than were urea, ammonium sulfate, or calcium nitrate. Phosphoric acid induced a similar-appearing breakdown of the internal root tissues and, in addition, caused a necrotic flecking of the older leaves. Chicken manure induced damage that was similar to that induced by the more toxic fertilizer materials.

Eleven separate field trials were conducted near Salinas to study the relative toxicity of five commercial nitrogenous fertilizer materials commonly used on lettuce in that area. The soils varied in texture from sandy loam to clay. The relative alkalinity-acidity—pH—ranged from an acidity of 6.2 to an alkalinity of 8.0 but only two of them were below neutral pH 7.0.

Plots were located in fields where random sampling of plants indicated that little or no injury had resulted from previous fertilizer applications. The materials were applied at several different rates—expressed as pounds of nitrogen per acre—to plants about one-half grown in a way that simulated a commercial side-dress application.

Observations for internal root injury were made at seven- to 43-day intervals after application. Although the amount and severity of damage resulting from the application of different materials varied from trial to trial, the relative toxicity of the materials was fairly constant.

Ammoniated ammonium nitrate and aqua ammonia—both contain free ammonia—were much more damaging than the other materials. Ammonium sulfate and calcium nitrate were relatively nontoxic, but both caused some typical root

damage at the higher rates, especially when 43 days had elapsed since application. The increase in amount of damage resulting from increased length of time after application, however, was most striking with urea. One explanation of this phenomenon might be that urea itself is relatively nontoxic, but that the toxicity is due to breakdown products from urea produced by microbial or chemical action in the soil.

To verify the indication that fertilizer materials that contain free ammonia, or other materials that are highly acidic, are more toxic than the neutral salts, two additional field tests were made. In each test five milliliters of different water dilutions of five fertilizer materials were injected with a hypodermic syringe directly into the root zone of 20 plants.

Relative Toxicity of Different Concentrations of Fertilizer Solution to Lettuce Roots^a

Material before dilution	Concentration as applied ^a (percentage N or P ₂ O ₅)	Number of plants of 20 classified according to extent of injury of central xylem core ^b			
		None	Slight	Mod-erate	Se-vere
Control no treatment		20	0	0	0
Aqua ammonia (20% N)	20.0	0	0	1	19
	10.0	0	0	1	19
	5.0	0	1	8	11
	2.5	3	5	9	3
Ammoniated ammonium nitrate solution (40% N)	40.0	0	0	0	20
	20.0	0	0	3	17
	10.0	0	2	0	18
	5.0	12	6	0	2
	2.5	15	3	2	0
Ammonium nitrate solution (20% N)	20.0	18	2	0	0
	10.0	18	2	0	0
	5.0	20	0	0	0
	2.5	20	0	0	0
Nitric acid (15.5% N)	15.5	0	0	3	17
	5.0	2	2	6	10
	2.5	6	14	0	0
Phosphoric acid (54% P ₂ O ₅)	54.0	0	2	3	13
	27.0	1	4	10	5
	10.8	8	6	6	0
	6.75	14	4	2	0

^a Five ml of each solution under test was applied with a hypodermic syringe at a depth of 7" directly into the root zones of 20 plants.

^b Examinations of the roots to determine extent of injury of the central xylem core were made five days after the materials were applied.

The results—which were an average of the two trials—show that aqua ammonia is slightly more toxic than ammoniated ammonium nitrate at the higher dilutions. Ammonium nitrate solution, which contains no free ammonia but contains as much nitrogen as the aqua ammonia formulation—20%—caused very little damage even when applied in the concentrated form. This is further evidence that the toxicity of aqua ammonia and of the 40% nitrogen formulation is due largely to free ammonia.

Tests of nitric and phosphoric acid indicate that both materials are toxic. However, they lost more of the toxicity

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