Refertilization of Rose Clover

carryover effects of superphosphate applied in one treatment compared with results from annual applications of same rates

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The first trials of rose clover in California were made in 1944 as part of Research Project 1194B. Rose clover, an annual reseeding legume, is well adapted to soils low in phosphate or sulfur and on which bur clover scarcely exists. It is a good companion crop for subterranean clover. In addition to increased green forage in the spring they produce high quality dry feed for summer and fall.

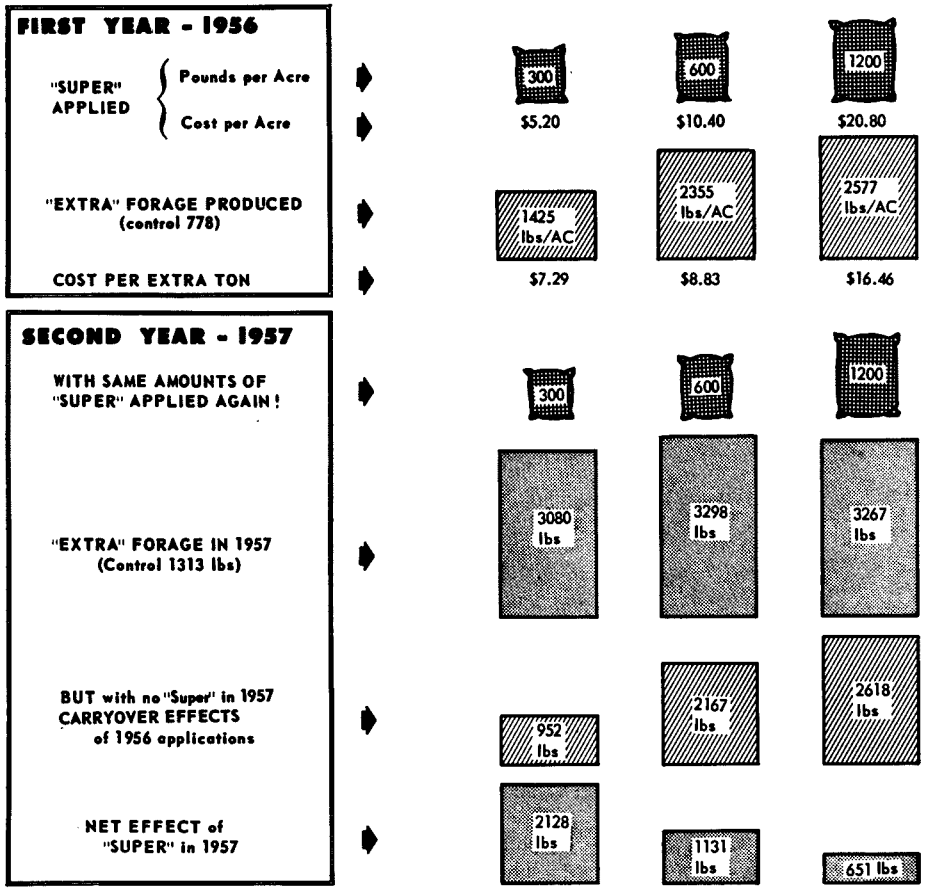
Range test plots of rose clover harvested in May 1957 showed striking second year or carryover effects where heavy—600 or 1,200 pounds per acre—applications of superphosphate were made in December 1955, but where only 300 pounds were applied the carryover effect was small.

The plots—on Placentia sandy loam near Lincoln—were established in a four-year-old stand of rose clover that had not been fertilized prior to December 2, 1955, when single superphosphate was applied at rates of 300 pounds, 600 pounds, and 1,200 pounds per acre.

The plots were harvested by clipping 34″ wide strips across each plot in mid-May 1956, when the clover was about a week past full bloom. Samples of the clipped forage were separated into the grass and legume components. The legume fraction was almost entirely rose clover, while the grass fraction contained a small amount of filaree. Analyses of the clover showed an increase of over 300% in total forage production, a 70% higher protein content, and 66% higher total phosphorus as a result of fertilization.

To study the carryover effects of the initial fertilization in comparison with plots where added applications of phosphorus were made, half of the original plots were treated again on December 5, 1956, with the same three rates of application—the remaining plots were not refertilized—and each treatment was repeated six times on strips 10′ × 87′.

Effect of superphosphate applied to rose clover forage.



EXTRA FORAGE IN 2 YEARS

WITH SINGLE APPLICATIONS	"Super" applied	300 + 0	600 + 0	1200 + 0
	Total Forage	2377	4522	5195 lbs/AC
	Cost per Ton	$4.38	$4.60	$8.06
SUPERPHOSPHATE EACH YEAR	"Super" applied	300 + 300	600 + 600	1200 + 1200
	Total Forage	4508	5653	5846 lbs/AC
	Cost per Ton	$4.62	$7.36	$14.35

Yields of Forage

Growing conditions were somewhat better in 1957 than they were in 1956 and were reflected in higher yields of both grass and clover on the nonfertilized plots.

Striking carryover effects from the initial phosphorus applications—at the higher rates—were observed in 1957. However, only about a third as much clover was produced in the plots treated with the 300-pound rate in 1955 as in the plots where the same rate was applied both years. At higher rates differences between the double and single applications were less. The greater the initial application of phosphorus the greater was the carryover effect as measured by growth of clover.

Grass was not appreciably affected by phosphorus the first year. Little increase in grass was observed on any carryover plots, although there were slight increases on plots where high rates of phosphorus were reapplied.

Increases in total forage production are shown in the diagram on this page. The 300-pound application of superphosphate per acre caused a 1,425-pound increase in forage per acre the first year, with a residual or carryover effect the second year of 952 pounds dry material per acre. Where 600 pounds were applied, 2,355 pounds additional forage were produced the first year and 2,167 pounds as a carryover effect. At the

Continued on next page

ROSE CLOVER

Continued from preceding page

1,200-pound rate the increase in production the second year was 2,618 pounds—slightly greater than 1956.

Increased yields in 1957 on the plots receiving additional fertilizer in all cases exceeded the yields on the carryover plots. Increases on repeat treatments were about the same for all three rates of application. However, these values included the carryover effect of the original fertilization as well as the effect of the second application. Subtracting the carryover effect of the first year's application shows that the yield increases due to reapplied phosphorus were much less where the high treatment rate was used than where lower rates were applied.

Cost of Extra Forage

On the basis of the fertilizer cost—per ton of extra forage produced—single applications of superphosphate produced additional forage the first year at a cost varying from $7.30 per ton at the 300-pound rate to $16.46 per ton at the 1,200-pound rate of application. When the residual effects—measured the second year—were added, the costs of the extra forage dropped sharply to $4.37 per ton where the 300-pound rate was originally applied, $4.60 for the 600-pound rate, and $8.08 where 1,200 pounds were used. Additional growth response may be expected from the highest rate in succeeding years.

Where the costs of annual applications were charged on a two-year basis, the 300-pound treatment produced additional forage for $4.61 per ton; the double applications of 600 pounds cost $7.36 per ton and the 1,200-pound rate cost $14.36 per ton. The total extra forage produced from the 300-pound rate—applied on two successive years—was almost exactly the same as that from a single 600-pound rate plus its second year carryover effects.

Forage Chemical Composition

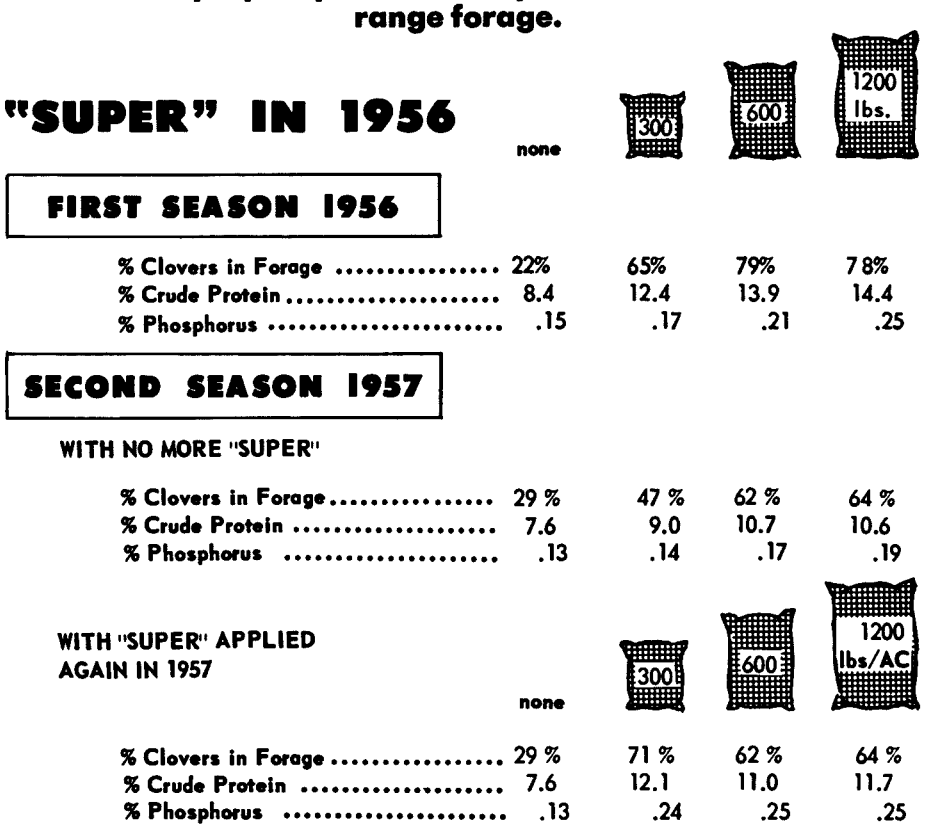
The rose clover and the grass were analyzed separately for crude protein and total phosphorus. At harvest, the grass contained only about half the per cent protein found in the clover. Although the protein content of both grass and clover was increased slightly by initial applications of superphosphate, the effect did not carry over into the second year. Where phosphorus was reapplied the protein content of both grass and clover was again increased slightly.

In contrast to protein values, the phosphorus content of the clover was lower than the grass in all treatments both years of observation. However, the per cent phosphorus of both grass and clover was increased greatly by fertilization the first year and in the second year where superphosphate was reapplied. On the carryover plots the increase in phosphorus content of grass and legume was much less. On the lightly fertilized carryover plots phosphorus values of both grass and legume were only slightly better than the control.

The proportion of high protein clover in the forage the first year was sharply increased by fertilization. As a result the per cent crude protein in the whole forage was increased from 8% up to about 14%. Because the phosphorus content of both grass and clover was increased by fertilization, the phosphorus content of the whole forage was sharply increased from 0.15% up to 0.25% phosphorus.

In the second year of the test—1957—the percentage of clover in the 300-pound carryover plot dropped significantly, resulting in forage of lower protein content. Reapplication of that same rate of material maintained a high clover percentage and kept per cent protein in forage at a high level. Other carryover treatments and reapplications at the higher rates showed a slightly smaller proportion of clover and slightly lower per cent crude protein in 1957 than in 1956. The percentage of high-protein clover in the forage was the primary factor in determining the protein content of the whole forage. Only in the plots receiving a single initial light application

Effect of superphosphate on composition of annual clover range forage.



Effect of Superphosphate Applications on Yield of Improved Clover Range

Fertilizer treatments* Lbs. single super/acre		Pounds Dry Weight per Acre					
		Yields of forage in 1956			Yields of forage in 1957		
1956	1957	Grass	Rose clover	Total forage	Grass	Rose clover	Total forage
None	None	658	120	778	949	364	1,313
300	None	757	1,446	2,203	1,236	1,029	2,265
300	300	...	...	...	1,198	3,195	4,393
600	None	720	2,414	3,133	1,165	2,315	3,480
600	600	...	...	...	1,702	2,909	4,611
1,200	None	740	2,565	3,305	1,368	2,563	3,931
1,200	1,200	...	...	...	1,605	2,977	4,582
LSD** 5%		n.s.	654	641	448	634	594

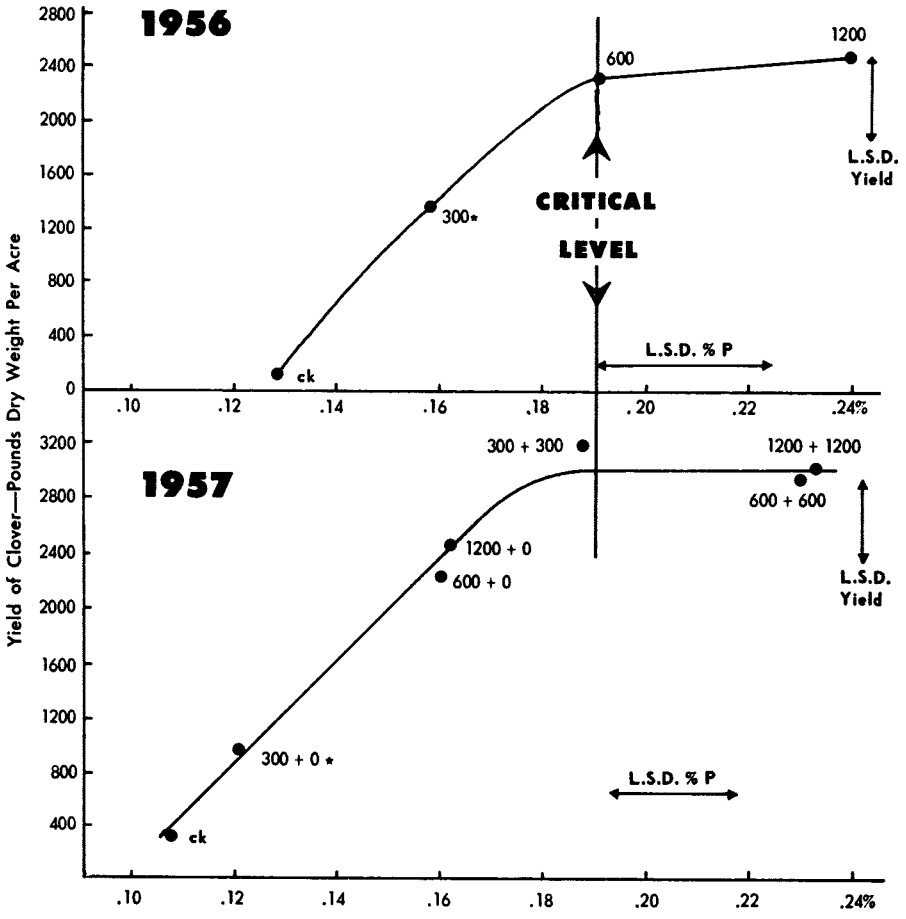
* 300, 600, and 1,200 lbs. superphosphate supplied 57, 114, and 228 lbs. P_2O_5—available phosphoric acid—per acre, or 25, 50, and 100 lbs. phosphorus per acre.

** Least significant difference at 5% level.

of superphosphate was there clearly a lower crude protein content, though even in this treatment the value was considerably above that of untreated forage.

The phosphorus values in 1957 were clearly less in the carryover plots than where reapplications were made. The phosphorus level in whole forage receiving the light initial application the first year was about the same as in the control. In contrast, the forage from the area receiving the light 300-pound application both years was about as high as the forage from the two higher rates of phosphorus.

Relation of per cent phosphorus in clover to yield and phosphorus applied.



* Pounds single superphosphate per acre in 1956 and 1957

Effect of Phosphorus Treatment on Per Cent Crude Protein and Total Phosphorus in Range Forage

Single superphos. applied	Per cent crude protein in separated species							
	Grasses				Rose clover			
	1956 initial	1957 season			1956 initial	1957 season		
		Carryover		Reapplied*		Carryover		Reapplied*
Check	7.0%	5.4%	=	5.4%	12.7%	12.5%	=	12.5%
300	7.6	5.6		7.3	14.6	13.1		14.2
600	7.5	6.0		7.3	15.9	13.1		13.3
1,200	8.2	5.8		7.3	16.2	13.3		14.3
L.S.D.**	1.2	0.8	=	0.8	0.8	0.8	=	0.8

Single superphos. applied	Per cent total phosphorus in separated species							
	Grasses				Rose clover			
	1956 initial	1957 season			1956 initial	1957 season		
		Carryover		Reapplied*		Carryover		Reapplied*
Check	0.157%	0.130%	=	0.130%	0.128%	0.109%	=	0.109%
300	0.197	0.169		0.319	0.157	0.122		0.187
600	0.253	0.185		0.277	0.190	0.162		0.230
1 200	0.308	0.233		0.291	0.238	0.164		0.232
L.S.D.**	0.035	0.036	=	0.036	0.034	0.021	=	0 021

*Superphosphate was reapplied prior to 1957 grazing season at the same rates on half of plots which received phosphorus in 1956.

** Least significant difference.

Uptake

The nitrogen uptake in the entire forage may be taken as an indication of the nitrogen-supplying power of the soil, plus the amount of nitrogen fixed by clover. In the forage samples harvested in 1956 and in 1957 the nitrogen uptake amounted to only 10.4 and 15.8 pounds per acre from the nonfertilized plots.

The improved growth of clover in the first season increased the nitrogen recovered in whole forage up to 69.6 and 76.2 pounds per acre at the two higher rates of phosphorus application.

Where phosphorus was reapplied the nitrogen in the forage was over 80 pounds per acre—an increase of more than 65 pounds of nitrogen—with no significant difference between rates of phosphorus applied.

The carryover plots, which received the initial treatment only, yielded considerably less nitrogen at each level of application than did the plots receiving the repeat treatments.

The phosphorus uptake of the whole forage may be used as a measure of the amount of phosphorus available in the soil of the test plots, plus the amount obtained from fertilizer applications. Only 1.18 pounds of phosphorus in 1956 and 1.66 pounds in 1957—2.7 and 3.8 pounds P_2O_5—available phosphoric acid —per acre—were recovered in the forage harvested in the nonfertilized areas. The amount of phosphorus in the harvested forage was greatly increased wherever superphosphate had been applied. Subtracting from those values the phosphorus found in the nonfertilized forage gives a rough measure of the amount taken up from the fertilizer. Recovery values are probably slightly high because the root systems of the fertilized plants were probably larger than those in the control area and explored a larger volume of soil for native phosphorus.

The apparent recovery of fertilizer phosphorus in 1956 was about 10.0% and 10.6% with the 300- and 600-pound rates of application and 7% where 1,200 pounds were applied. The additional uptake in 1957—with no repeat treatment —raised the apparent recovery up to 16% from 300 pounds, 19% from 600 pounds, and 12.8% with the 1,200-pound application. The apparent recovery of phosphorus in 1957 from the repeat applications in 1956 was 26.7% on the 300 pounds, 11.4% from the 600-pound rate, and only 3.4% where 1,200 pounds of superphosphate were applied.

Concluded on page 14

ASPARAGUS

Continued from preceding page

should be greater, but on the 10% basis the machine-harvested yield would be 55% of the yield from commercial hand cutting.

During periods not affected by disking, the hand-cut rows and the machine-cut rows on the clay loam plot produced about the same total number of spears. Nearly three fourths of the reduction in yield with machine harvesting was due to the high percentage of spears that were shorter than 3½" when cut. The smaller average weight per spear in comparison with 4½"-green hand cutting accounts for another fifth of the yield reduction. The loss of spears over 3½" missed by the machine is of minor importance.

Cost Comparison

At a speed of 3½ miles per hour, a one-row harvester operating in a field with a 7' row spacing should average 2¼ acres per hour and take care of 125 acres. This would require operating 12½ hours per day to cover the acreage in 4½ days as would be required in hot weather. During most of the season, 9–11 hours per day would be adequate. The harvester and operator would replace 15 hand cutters as well as the two men and motorized cart now required to haul out hand-cut asparagus.

To arrive at a cost comparison for machine harvesting and hand cutting, the first cost of the harvester—with tractor—was estimated at $3,500, total overhead and operating costs for the harvester—including blade replacement in abrasive soils—was estimated at $10 per acre per season, and it was assumed that 125 acres would be handled by one machine. The hand-cut yield—on a 7" basis—was assumed to be 2,500 pounds per acre, and a typical price paid to grower on the same 7" basis was considered to be 10¢ per pound. Labor cost for cutting and sledding was taken as 3¾¢ per pound plus $40 per man per season for bringing in Mexican Nationals and for other miscellaneous expenses. The wage rate for the harvester operator was figured at $1.25 per hour; total overhead and operating costs for present motorized carts at $2.50 per acre per season. On the basis of the 2,957 field tests, the machine-harvested yield was considered to be 55% of the hand-cut yield.

The total estimated savings per acre, resulting from the elimination of the hand cutters and the motorized carts, would be $103. Total machine-harvesting charges, including loss of yield, would be $129 per acre. Thus, neglecting other economic differences, the grower's annual income would be reduced $26 per acre by the use of the mechanical harvester. For the assumed conditions and estimated costs, mechanical harvesting and hand cutting would yield the same net return per acre if the machine-harvested yield were 65% of the hand-cut yield.

Improvement of Yields

Machine-harvested yields would be significantly increased if the percentage of short spears could be reduced. It is possible that existing asparagus varieties may be found or new varieties developed that will have a tendency to cycle when harvested by the set-level method. There is limited evidence from earlier tests that—under some conditions—the percentage of spears longer than 3½" is somewhat greater than observed in the current tests. The effects of cultural practices, height of the bed over the crowns, and various other factors need to be investigated.

Another factor that would affect the ratio between hand-cut yields and machine yields is the age of the beds. Because both fields selected for the 1957 tests were rather old, the spears emerging from each crown were distributed over a relatively large area. In younger beds, where the spears are much closer together, hand cutters could be expected to damage or cut off more short spears adjacent to the one being harvested. Thus, the machine-versus-hand yield ratio should be higher in young beds than

Concluded on page 20

ROSE CLOVER

Continued from page 9

Plant Tissue Analysis

To estimate the phosphorus needs of rose clover in the 1957 growing season, plant tissue analyses were made of samples harvested in 1956. By using the basic principle of plant tissue analysis—that the chemical composition of a plant reflects its soil nutrient supply—the critical level of total phosphorus in the entire top at the late-bloom stage of development was determined to be 0.19%. Plants with a phosphorus level below that value were deficient, and a growth response to additional phosphorus could be expected. Plants at or above the 0.19% level could not be expected to respond to phosphorus applications.

Results obtained in 1957 fulfilled expectations. Plots that received the 300-pound per acre treatment in 1955 produced clover with a phosphorus value of 0.16% in 1956 and clearly responded in 1957 to the repeat treatment. Plant composition and yield were reduced in 1957 where no repeat phosphorus treatment was applied in 1956. Where 600 pounds of superphosphate were applied in 1955 the phosphorus value in the clover in 1956 was 0.19%. Additional phosphorus applied at the same 600-pound rate in 1956 caused an increase in yield which was not quite significant statistically. Refertilization of plots originally treated with 1,200 pounds of superphosphate and which produced clover with a phosphorus value of 0.24% in 1956, showed—after retreatment—a slight but not statistically significant increase in yield in 1957.

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Effect of Fertilizer Treatment on Uptake of Nitrogen and Phosphorus in Range Forage Expressed as Pounds Total Nitrogen and Total Phosphorus per Acre

Fertilizer treatment			Nitrogen uptake in forage			Phosphorus uptake in forage			Apparent phosphorus recovery		
Superphos. applied per acre	Lbs. P per acre*		First year 1956	Second year—1957		First year 1956	Second year—1957		As % of original phosph. applied		As % of reapplied phosphorus 1957
	Single applications	Repeat applications		Carryover	Additional P applied		Carryover	Additional P applied	1st yr. 1956	Carryover 1957	
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	%	%	%
Check	...	...	10.4	15.8	15.8	1.18	1.66	1.66	...	..	...
300	24.9*	49.8	43.0	32.3	86.6	3.68	3.26	9.93	10.0	6.5	26.7
600	49.8*	99.6	69.6	59.8	81.7	6.48	5.80	11.49	10.6	8.4	11.4
1,200	99.6*	199.2	76.2	66.7	85.8	8.36	7.27	11.52	7.2	5.6	4.3

* These values correspond to 57, 114, and 228 pounds P_2O_5—available phosphoric acid—per acre.