Wimmera Ryegrass and Lana Vetch for Forage on Marginal Grainlands[1]

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Over 200,000 acres of rolling land in southern California are farmed in a fallow-grain cropping system. Soil erosion is a problem on this land. In some localized areas yields have declined during dry periods until cropping for grain production was no longer economically feasible. The low fertility status of the soils is a factor in the low production. A study of the establishment and production of annuals for forage was required before recommendations for changing cropping systems or abandoning the land for farming could be evaluated.

Previous results indicate that considerable risk is involved in fertilizing for grain production where average annual rainfall is less than 10 inches. Martin and Mikkelsen (1960) report that beneficial response of nonirrigated grain to nitrogen application occurred in 29 percent of their tests where rainfall was less than 10 inches. Vegetative growth of plants is increased by application of nitrogen, but the available soil moisture is exhausted and rainfall normally decreases before the crop matures, resulting in reduced grain yields. Increases in forage yield from nitrogen application therefore are more likely to occur under these moisture conditions than increases in grain yield.

The objectives of this study were (a) to increase the yield and quality of forage by applying nitrogen and phosphate fertilizer, and (b) to compare methods of seedbed preparation and planting for obtaining emergence of Lana vetch and Wimmera ryegrass.

Field work was initiated in the fall of 1953 on recently abandoned grainland near Murrieta, California. The soil was classified as Perris fine sandy loam. Slopes range from six to 14 percent, and the surface has undergone moderate to severe erosion. Analysis of the surface soil showed an average total nitrogen content of 0.04 percent and low available phosphorus. The average annual precipitation is about nine inches in this winter rainfall area. The length of the effective rainfall season usually limits the growing season under non-irrigated conditions to 150 days or less.

Experimental Plan And Procedures

The 3-year crop rotation used in these studies was barley or oats—pasture—fallow. Wimmera ryegrass was seeded at six pounds per acre and Lana vetch at 15 pounds per acre. All fertilizer for the forage crop was applied with the seed. Nitrogen was used at different rates four years and in combination with phosphate three years. Methods of application were studied one year. Treatments were replicated from two to six times. Except for the 1959-60 crop year, when several tillage and planting methods were compared, no tillage was done prior to seeding the pasture crop.

Yield measurements and chemical analyses were made each year, and in certain years other forage crop measurements were also obtained. Forage samples were obtained by clipping three or more ¼-milacre areas per plot. Plants were clipped at a height of one inch and dried at 60°C before weighing.

Results

Dry matter yields of annual forage were obtained over a period of seven years (Table 1). The average forage yield increase from the application of 35 pounds of nitrogen per acre was 1,220 pounds. Statistically significant yield increases were obtained in four of five years. Increases were greater during high rainfall years, and ranged from 100 to 250 percent.

The application of phosphate fertilizer with nitrogen had little or no effect on forage yield. Small increases over yields with nitrogen alone in 1956, 1957, and 1958 were not statistically significant.

The application of nitrogen fertilizer has usually been found to influence the crude protein content of the forage produced. Generally, crude protein percentages were increased by nitrogen application in this experiment (Table 2). The average increase with 35 pounds of nitrogen per acre was 0.59 percent. Crude protein of forage on nitrogen-fertilized plots varied from 1.69 percent less to 3.69 percent more than on check plots. Phosphate applied with nitrogen did not have a consistent effect on protein percentage. The 4-year average was 0.92 percent less where phosphate was used.

A more consistent relationship between the application of fertilizer and crude protein in the crop is apparent in the calculated protein yields (Table 2). With the exception of 1956, very marked and consistent increases in the amount of protein produced per acre were obtained with fertilizer application. Where 35 pounds of nitrogen were applied,

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Table 1. Effect of nitrogen and phosphate on average dry matter yields of annual forage.[1]

Year	Rainfall[2]	N-P_2O_5 (lb./A.) 0-0	35-0	35-45	50-60
	inches	— — — — (Pounds per acre) — — — —			
1954	——	1810	——	3470	5970
1955	12.78	580	2150	——	1900
1956	7.17	560	310	500	700
1957	10.51	960	2140	2570	——
1958	16.43	1370	4310	4440	——
1959	8.35	780	——	1520	3340
1960	6.53	580	1230	1160	——
5-yr. avg.	10.68	810	2030	——	——
4-yr. avg.	10.16	870	2000	2170	——
3-yr. avg.	——	1060	——	1830	3540

[1] Wimmera ryegrass and volunteer barley, 1954-58; ryegrass, barley, and Lana vetch, 1959-60.

[2] Recorded 12 miles from plots; unofficial records indicate amounts received at experimental site were from 1 to 2 inches less.

the average increase in protein yield was 79 pounds, or 122 percent. Generally, small addtonal increases in protein yield were obtained when phosphate was applied with similar rates of nitrogen. A higher rate of both nitrogen and phosphate (50-60) resulted in much higher protein yields.

Forage samples taken in 1955 were analyzed for phosphorus content. Phosphorus percentages were 0.26, 0.16, and 0.33 for the check, 35-0, and 50-60 treatments, respectively. The amount of phosphorus in the forage on an acre basis was increased 128 percent by the application of 35 pounds of nitrogen, and 316 percent by the application of 50 pounds of nitrogen and 60 pounds of phosphate.

To determine if fertilizer treatments were having a differential effect on the yield of grasses and the legume in the mixture, samples taken in 1960 were separated into two components—grasses (which included volunteer barley with Wimmera ryegrass) and Lana vetch. The dry matter yields from plots which were drilled at seeding are presented in Table 3.

In the unfertilized plots, grass forage constituted 84 percent of the dry matter produced. Where 35 pounds of nitrogen were applied, grass forage was increased to 95 percent. The effect of nitrogen in increasing the grass: vetch yield ratio was manifested by both higher grass yields and lower vetch yields.

Methods of seedbed preparation and planting were studied during the 1960 growing season. Tillage treatments included the following: (1) no tillage, (2) shallow disking prior to seeding, (3) shallow disking after seeding, and (4) shallow disking both before and after seeding. The two methods of seeding the ryegrass and vetch mixture, used with all tillage treatments, were drilling and broadcasting. After seedling emergence, counts of vetch and ryegrass plants were made (Table 4).

Drilling was consistently superior to broadcasting with all tillage methods for obtaining a stand of vetch. Shallow disking after broadcasting was beneficial, but did not increase emergence sufficiently to make broadcasting comparable to drilling for planting vetch. Broadcasting with no tillage resulted in the thinnest stand of ryegrass. Disking after planting appeared to be beneficial for ryegrass emergence.

Fertilizer was applied with the seed and methods of planting therefore indicate methods of fertilizer application. With the exception of the grass on the unfertilized plots, much less total grass and vetch growth was produced on broadcast plots than on drilled plots (Table 5).

Since application of fertilizer did not greatly change the ratio of drilled to broadcast vetch yields, reduced emergence on broadcast plots (Table 4) largely accounts for reduced vetch yields on broadcast plots. Yields of fertilized grass on drilled plots were about 50 percent greater than on broadcast plots, while on the unfertilized plots planting methods did not affect yield. More efficient use of fertilizer apparently resulted from the drilled placement with the seed, as compared with broadcasting on the surface.

Table 2. Effect of nitrogen and phosphate on the percent and yield (pounds per acre) of crude protein in annual forage.[1]

Year	N-P_2O_5 (lb./A.) 0-0		35-0		35-45		50-60	
1954	6.12	111	—	—	5.25	182	5.62	342
1955	9.06	49	9.25	184	—	—	11.38	218
1956	11.62	66	15.31	48	11.19	57	10.50	74
1957	6.81	65	7.56	161	6.25	157	—	—
1958	4.00	55	4.00	171	5.00	223	—	—
1959	7.00	55	—	—	7.30	111	7.12	238
1960	11.75	90	10.06	158	10.81	168	—	—
5-yr. avg.	8.65	65	9.24	144	—	—	—	—
4-yr. avg.	8.54	69	9.23	134	8.31	151	—	—
3-yr. avg.	8.25	77	—	—	7.91	117	7.75	218

[1] Wimmera ryegrass and volunteer barley, 1954-58; ryegrass, barley and Lana vetch, 1959-60.

Table 3. Dry matter yields[1] of grasses and vetch in a mixed crop with fertilizer application, 1959-60.

	$N-P_2O_5$ applied (lb./A.)		
	0-0	35-0	35-45
	(Pounds per acre)		
Grasses[2]	507	1487	1330
Vetch	93	24	58

[1] Average of 4 plots.
[2] Volunteer barley and Wimmera ryegrass.

Discussion

This study has shown that forage production of annuals is greatly increased by the application of nitrogen fertilizer under moisture conditions which usually will not support satisfactory small grain production. At seeding rates with a grass to legume ratio similar to that used in this study and under nitrogen fertilization, grasses can be expected to dominate vegetative growth and ground cover. The increased production obtained with fertilizer application was entirely accounted for by increased growth of grasses. Reduced legume production in grass-legume mixtures fertilized with nitrogen has previously been reported (Parsons, 1958 and Rouse *et al.* 1955). Pasture mixtures with a greater percentage of legume probably would have responded more to phosphate fertilizer on similar soil.

With the low and variable annual amounts of rainfall, it appears that the quantity of available moisture has a greater effect on the year-to-year crude protein percentage in forage than does the application of relatively low rates of applied nitrogen. Dry matter and protein yields were directly related to rainfall, but percentage of protein was inversely related. The relation between percent of nitrogen in the plant and the increase in yield from added nitrogen at different levels of deficiency has been reviewed by Russel (1950). Although protein content was not always increased by adding nitrogen fertilizer in this experiment, more forage was produced, usually without a reduction in quality.

Table 4. Seedling emergence of Wimmera ryegrass and Lana vetch with different seedbed preparations and methods of planting.

Seedbed preparation	Average number of plants per sq. ft.[1]			
	Vetch		Ryegrass	
	Drilled	Broadcast	Drilled	Broadcast
No tillage	3.9	1.4	6.2	5.7
Disking before planting	3.0	1.8	6.8	7.7
Disking after planting	3.4	2.8	8.1	8.1
Disking before and after planting	3.6	2.2	7.6	8.8
Average	3.5	2.0	7.2	7.6

[1] Average of 30 square-foot quadrats.

The degree of seedbed preparation necessary for pasture will vary with soil type. This study shows, however, that the seed of large-seeded legumes, such as vetch, must be covered for a satisfactory stand. With the smaller-seeded ryegrass, this was much less of a factor.

Including annual pasture in dryland cropping systems or changing land use from grain crops to annual pasture will reduce soil erosion on steep lands and will probably increase the return from what now are considered marginal grainlands. These are desirable alternatives to abandoning the land or continuing the fallow-grain system in low rainfall areas. The use of adapted grasses and legumes and the application of fertilizer are two important considerations when annual pasture is included in dryland cropping systems.

Table 5. Relation of forage yields to methods of planting and placement of fertilizer.

Fertilizer application $N-P_2O_5$	Dry matter yield[1]			
	Vetch		Grasses	
	Drilled	Broadcast	Drilled	Broadcast
	(Pounds per acre)			
0-0	93	7	507	551
35-0	24	2	1487	938
35-45	58	4	1330	937

[1] Average of 12 samples.

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