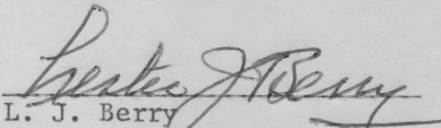


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**UNIVERSITY OF CALIFORNIA
AGRICULTURAL EXTENSION SERVICE**

Date: September 14, 1967
To: Warren Sharratt

DAVIS, CALIFORNIA

From: _____ & 
Title: W. E. Martin Extension Soils Specialist & L. J. Berry Extension Range Specialist
Re: Tentative Outline of Proposed Cooperative Project

Enclosed is a very tentative draft of a proposed project which we would like to initiate this fall in an effort to get started on some rate and source studies comparing TVA S-fortified treble (0-40-0-20S) with standard single superphosphate.

We have endeavored to gather together all our data to date using TVA materials furnished us.

You will note that we have put no charge for fertilizer materials in the project--expecting to use donated fertilizer entirely. Our big need is for dollars for fencing and operations. The tentative total comes to \$4,000.

WEM:LJB:st

Enclosure

Proposed Cooperative Project Between Fertilizer Branch TVA & University of California
Agricultural Extension Service

FIELD EVALUATION OF SULFUR FORTIFIED CSP

Objective:

To determine under field conditions the relative effectiveness and longevity of response of sulfur fortified superphosphate (TVA 0-40-0-20S) as compared to normal superphosphate as a fertilizer for forage legume species on soils deficient in both P & S.

Introduction to the Problem:

Many areas of California ranges, pastures and irrigated croplands, devoted to production of annual clover, irrigated pasture, or alfalfa, are deficient in phosphorus, sulfur or both. Dual deficiency of P & S is particularly common in the rangeland areas of northern and central California where major efforts are being made to improve production by the establishment of annual clover plantings using rose or subterranean clovers. Normal superphosphate (0-21-0-12S₄-S) has been the standard fertilizer material for such locations. At some locations in the high rainfall zone (28" - 40") leaching of sulfate has been shown to be a serious problem. Here elemental S has been found to be more effective particularly in the second and third seasons after application. It has been felt in such areas the use of treble superphosphate fortified with elemental sulfur (0-40-0-20S) might offer advantages as a long lasting dual nutrient fertilizer with the added advantage of high analysis and attendant lowered application costs.

Previous Studies with TVA CPS + S:

a) Thirty-five exploratory range fertilizer tests were set up in 1965 for harvest during the 1966 season. In these tests, efforts were made to find out where phosphorus, sulfur, potassium, or molybdenum limited the growth of range legumes, and whether response from TVA sulfur fortified treble superphosphate differed from that observed from the use of sulfur-free treble superphosphate plus equivalent sulfate-sulfur in gypsum.

In most sections of the state, with little or no rain after February. Yields of six plots in the wetter areas of the State where there was good spring rain illustrate the type of responses obtained. As had been anticipated, the major responses were either to phosphorus or sulfur alone, and at several locations to both nutrients. At one location, molybdenum was observed to be important. In the extreme northern coast, in Del Norte County, response to potassium in addition to phosphorus and sulfur was noted.

Results from the sulfur-fortified treble (0-40-0-20S) were at least equal to equivalent P + SO₄ from treble & gypsum. At two locations the sulfur fortified material was markedly superior.

Table I. YIELD OF FORAGE IN RANGE EXPLORATORY TESTS*

Treatment	<u>Sonoma Co.</u>		<u>Tuolumne Co.</u>	<u>Shasta Co.</u>	<u>Mendocino Co.</u>	<u>Del Norte Co.</u>
	Sessions	Black	Emerson	Lemm	Maillard	Ulrich
None	2042	687	2640	1611	1513	4861
P	1814	1093	2750	2321	2112	5054
SO ₄	2663	833	2450	1660	1536	4941
P + SO ₄	2743	1250	2330	2025	2109	5495
P + SO ₄ +K	2949	944	2650	2415	1935	6726
PSS	2866	1499	2970	3744	2278	5504
PSSMo	2939	1191	2780	3362	2665	5527
Major Response	S	P	PS	PS	PSMo	PS K

* As lbs dry material per acre. P = 187 lbs/Ac = 0-54-0

SO₄ = 300 lbs./Ac gypsum, K = 200 lbs./Ac from KCl, PSS + PSSMo 250 lbs./Ac of TVA 0-40-0-20S with and without Mo coating.

b) Second year carryover from 1965 Range Exploratories

Carryover effects were observed on as many of the 1965-66 sites as possible. Yields were measured by clipping at nine locations. Results are shown in Table 2.

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SUMMARY OF SECOND YEAR CARRYOVER - EFFECTS OF 1965-1966 RANGE EXPLORATORIES AS PERCENTAGE OF DRY-MATTER YIELD OF UNTREATED PLOTS

County:		Cooperator:		Mariposa	Del Norte	Shasta	Sonoma	Sonoma	San Joaquin	Placer	Placer	Taylor	Schoellerman	Average	
Pinyon Creek		Tryon		Lemm	Black	Sessions	Kent	Hawkins	977	4845	1929	Treatments			
Untreated Lbs.		Dry Matter Per		Acre Yield: +		1848	2371	1800	963	831	1237	2497	977	4845	1929
100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Gyp.	138	143	135	78	123	109	101	118	94	115	121	132	140	149	145
P	132	149	145	164	89	111	91	102	104	121	135	140	149	159	145
P + Gyp.	140	135	189	140	165	108	135	122	111	138	140	149	159	159	145
P + Gyp. + K	157	149	159	121	142	99	112	124	115	131	138	140	149	159	145
PSS	234	159	251	145	204	116	121	103	161	161	161	161	161	161	161
PSSMo	218	164	239	141	197	109	130	105	160	160	160	160	160	160	160
L.S.D.	54	42	43	33	86	---	40	---	---	---	---	---	---	---	---
C.V.	10.8	17.1	10.2	21.0	10.6	15.5	11.4	18.8	13.1	---	---	---	---	---	---
Major Response	PS	P	PS	P	S	None	PS	None	PS	PS	PS	PS	PS	PS	PS

P at 100 lbs P₂O₅/A or 45 P/A

S at 50 lbs S/A

Mo at 1 ppm

Sulfur fortified treble gave clearly superior carryover effects at two of the nine locations. At no location was it inferior. Results at the Shasta: Lemm site were clearly in favor of CSPS in both the first and second seasons. Plant samples showed significantly higher SO_4-S and total S where PSS and PSS Mo had been applied. Visual observations at the three other locations showed clearcut superiority in residual effects from the PSS & PSS Mo applications.

c) Time and Source of P & S Experiment:

A series of 12 replicated factorial field experiments were set up in the fall of 1966 to determine when P and S should be applied (spring or fall) and whether elemental S or $Ca SO_4$ was superior. Sites were selected where P, S or P & S were thought to be deficient and where good stands of responsive legumes were present. The first years results are shown in Table 3. At no location was sulfur fortified treble (0-40-0-20S) clearly superior to equivalent normal superphosphate. Average yields of two materials were nearly equal. Sulfate at some locations gave larger yields than did elemental S. With the late spring rains of 1967, the later applied P and S did about as well as that applied in the fall. These plots will be observed in 1967-68 for residual effects.

Proposed Field Studies - for CSPS Field Evaluation:

Preliminary field studies have indicated that sulfur fortified treble is at least equal to equivalent P & S in normal superphosphate and at a few locations it appears markedly superior, particularly in its carryover effect on S deficient soils.

Number of Locations:

It is proposed that 10 replicated rate studies be set up in areas where P & S are known or suspected to be deficient. These tests will be observed for three seasons (2 after initial year). They will be seeded to responsive legume (clover or alfalfa) if none are present and fenced against deer and rodents as necessary.

Layout:

The plots will be set up with the following treatments. Normal superphosphate

1967

TIME & SOURCE OF P & S EXPERIMENTS - FIRST YEAR RESULTS ON ANNUAL CLOVER RANGE
AS PERCENTAGE OF DRY-MATTER YIELD OF UNTREATED PLOTS

Cooperator:		Material		Untreated lbs.		Material		Time		Rate					
Butte El Dorado Madera Madera Mariposa S.L.O. Shasta Stanislaus Tuolumne Tehama Yolo Average		Ahart Krell Fulton Smith Piney Righetti Murrey Bolling Jury Teisseire Durst Yield		Ahart Krell Fulton Smith Piney Righetti Murrey Bolling Jury Teisseire Durst Yield		Ahart Krell Fulton Smith Piney Righetti Murrey Bolling Jury Teisseire Durst Yield		Ahart Krell Fulton Smith Piney Righetti Murrey Bolling Jury Teisseire Durst Yield		Ahart Krell Fulton Smith Piney Righetti Murrey Bolling Jury Teisseire Durst Yield					
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
None	187 lbs. TSP	TSP	300 lbs. Gyp.	500 lbs. SSP	Gyp. + TSP	50 lbs. El. S	250 lbs. TSPS (0-40-0-20 S)	El. S + TSP	Gyp.	TSP + Gyp.	SSP	El. S	TSP + El. S	TSPS	TSPS + Mo
---	P _E	P _L	SO ^{4E}	P _E SO ^{4E}	P _L SO ^{4E}	S _E	P _E S _E	P _L S _E	SO ^{4L}	P _E SO ^{4L}	P _L SO ^{4L}	S _L	P _E S _L	P _L S _L	P _E S _{Mo}
100	108	93	96	100	104	88	116	118	93	92	111	97	102	91	111
100	108	101	109*	98(116)189	213	138	100	170	100	97	106	146	147	98	104
100	130	102	131	177	148	117	207	83	109	173	150	148	167	109	207
100	148	135	135	201	178	129	227	182	103	185	198	139	184	180	206
100	119	122	107	128	119	96	122	125	101	116	121	103	111	119	126
100	124	125	111	148	145	111	133	118	116	142	148	116	133	141	126
100	104	103	118	123	139	117	144	127	145	120	133	118	114	106	121
100	134	134	148	155	160	109	157	166	127	155	166	154	144	147	169
100	141	147	94	147	150	87	137	154	122	141	145	84	133	144	164*
100	131	127	188	219	197	150	207	185	150	189	146	135	187	186	180
100	123	121	128	153	151	111	156	139	120	142	145	120	139	138	152
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
+	-16	-12	-35	---	---	+	-54	-18	---	---	+	-39	-28	-23	+
ps?	-S+K	S,PS	PS	PS	P	PS	S	P,PS	P,PS	P,PS	S	P,PS	P,PS	P+Mo	S,PS
6.3	15.4	9.8	7.0	4.0	5.6	8.4	12.6	4.2	7.0	8.4	---	---	---	---	---

(0-20-0-12 $\text{SO}_4\text{-S}$) will be applied at 500, 1000, and 2000 lbs. per acre and compared with CPS (0-40-0-20S) at half the rate or 250, 500, and 1000 lbs. per acre. These rates will provide equal amounts of P at 50, 100, and 200 lbs. P_2O_5 with three approximately equal rates of $\text{SO}_4\text{-S}$ and elemental S from each material. Plots will be 5 x 200 ft.* with each treatment replicated four times as indicated in Fig. 1.

Harvest:

Yields will be determined by mechanically harvesting a portion of each treatment each season. One third of the experimental area will be protected from grazing the first season (1967-68) and used for yield. The balance will be grazed by range animals. The second year (1968-69) a fresh area previously grazed, will be fenced off for yield, and the final year (1969-70) the remaining one third will be fenced and harvested for yield.

Laboratory Studies:

Samples will be taken from each treatment for laboratory study to relate treatment to observed response to P & S fertilizer. Legumes and associated grasses will be hand separated for moisture studies and chemical analysis to relate chemical composition to observed fertilizer response and to determine the nutritive quality of the forage.

Tentative Budget

1. Fertilizers

(TVA) C.S.P. & S. (0-40-0-20S) 240 lbs./plot x 10 plots	2400 lbs.
(Industry) normal super (0-20-0-12S ₄ -S) 480 lbs./plot x 10 plots	4800 lbs.

2. Fencing Materials

1 acre plots, 1000 ft. fence @ .25/ft. = \$250 x 10 plots	\$2500
plus deer fence where necessary \$200 x 5 plots	1000

3. Legume Seed @ \$30/plot x 10 plots 300

4. Operations: Former cooperator and AES Personnel to be responsible for the following:

- a) Land preparation
- b) Plot establishment and fencing
- c) Plot harvest
- d) Parallel greenhouse studies
- e) Chemical analysis of forage
- f) Statistical analysis of data
- g) Preparation of reports

5. Miscellaneous costs for temporary student labor in species separation, preparation of samples for analysis and in greenhouse work where necessary. 200

ESTIMATED TOTAL CASH COST \$4000

Fig. 1

PHOSPHORUS SOURCE & RATE EXPERIMENT

Single Superphosphate Vs. Sulfur Fortified Treble
 (0-21-0-12 SO₄-S) (0-40-0-20 SS)

SUGGESTED LAYOUT

Fence 210'

1.	2000 SSP ✓		
2.	1000 TSP + S		
3.	1000 SSP		
4.	500 TSP + S		
5.	500 SSP		
6.	250 TSP + S		
7.	Check		
8.	2000 SSP		
9.	1000 TSP + S		
10.	500 TSP + S		
11.	1000 SSP ✓		
12.	250 TSP + S ✓		
13.	500 SSP ✓		
14.	Check ✓		
15.	1000 SPS		
16.	500 TSP + S		
17.	250 TSP + S		
18.	500 SSP		
19.	1000 TSP S		
20.	2000 Super S		
21.	Check		
22.	500 SSP		
23.	250 TSP + S		
24.	500 TSP + S		
25.	1000 SSP		
26.	Check		
27.	1000 TSP + S		
28.	2000 SSP		

Area I
 Fertilized Fall 1967
 Harvest Spring, 1968
 Observed 1969
 Observed 1970

Area II
 Fertilized Fall 1967
 Grazed 1967-68
 Harvest Spring 1969
 Observed 1970

Area III
 Fertilized Fall 1967
 Grazed 1967-68
 Grazed 1968-69
 Harvest Spring 1970