TEMBLOR RANGE RESEARCH

Parker

ANNUAL REPORT

1967-1968

UNIVERSITY OF CALIFORNIA

Departments of Agronomy-Davis, Riverside

COVER PHOTO

View of Elkhorn Experimental Site taken from Panorama Hills looking toward the northeast with the Temblor Range in background. The light colored areas on the right and center are the herbicide fallow treatments which are devoid of vegetation in the first year of fallow. The bare areas in center are deep furrows in the fallow treatments of the previous year. The dark area on the left is a forage variety nursery containing 93 accessions. Photo taken March 28, 1968.

FORWARD

This research is conducted by the Department of Agronomy and Range Science in accordance with Supplement No. 3 to the Master Memorandum of Understanding between the Bureau of Land Management, Department of the Interior, and The Regents of the University of California. Effective date of Supplement is September 13, 1963.

The work is supported in part by grants from the Counties of Kern and San Luis Obispo emanating from Taylor Grazing Fees.

Again we wish to express our thanks to the Boards of Supervisors of Kern and San Luis Obispo Counties, Farm Advisors James Clawson and Roy Parker, and officials of the Bureau of Land Management. The continued interest and help of Mr. Carl Twissleman is also acknowledged.

Mr. Jerry Chatterton continues to work on the ecology and physiology of saltbush for the Ph.D. degree. Cameron Duncan and Philip McGoldrick of Riverside will be assisting Mr. Chatterton. Richard E. Owen will be assisting in the projects originating from Davis.

The cooperation of the San Luis Obispo County Office of the Agricultural Commissioner in poisoning the rodents is acknowledged. Without their continuing control efforts it would not be possible to do range seeding research in this area.

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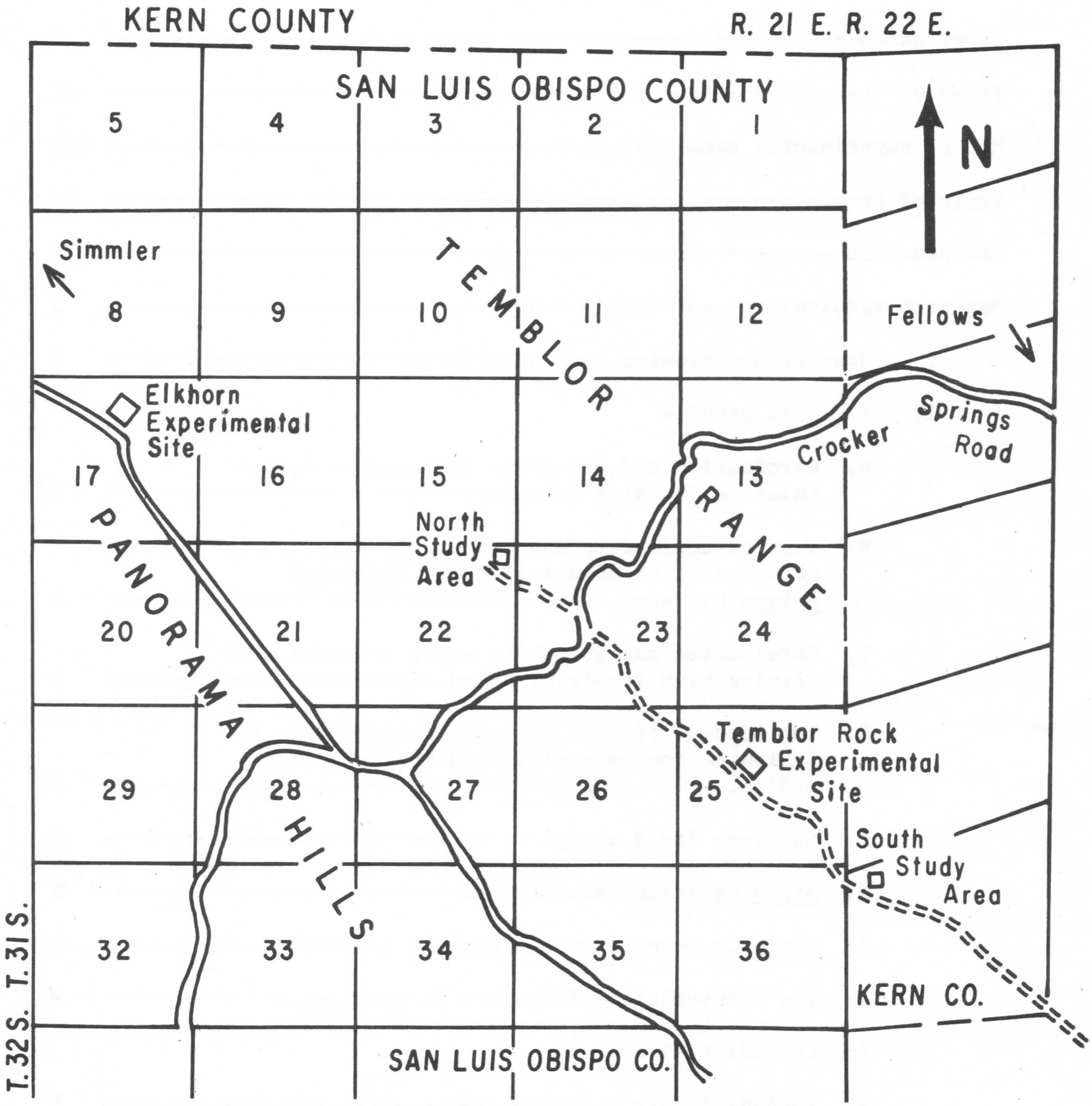
September 1, 1968

TEMBLOR EXPERIMENTAL SITES



TEMBLOR RANGE RESEARCH
University of California
Department of Agronomy and Range Science
Davis, Riverside
1967 - 68

INTRODUCTION

Total forage production of the resident vegetation was similar the last two years despite the dissimilarity of the two growing seasons. Total forage production was 780 and 560 lb/acre respectively for Temblor Rock and Elkhorn sites in 1967-68 compared to 700 and 600 lb/acre in 1966-67. Thus it appears that while the resident vegetation is well adapted to the dry conditions such as 1967-68, these same plants are not capable of fully utilizing the better growing conditions such as existed in the spring of 1967. We hope that by introducing new plants into the environment we will find adapted plants that also produce abundant forage on the better years as well as survive the poor ones.

Field tests in Kern Co. indicate that saltbush (*Atriplex polycarpa*) is not perpetuating itself under natural conditions. The many studies on this valuable browse species are performed in the belief that by understanding the basic requirements of this plant that it can be managed to not only perpetuate itself but to increase browse production.

I WEATHER AND GROWING CONDITIONS

Rainfall in 1967-68 was only slightly more than half of the 1966-67 amounts. Total rainfall at Temblor Rock experimental site and Elkhorn experimental site was 6.76 inches and 6.58 inches in 1967-68 compared to 11.44 and 11.03 inches in 1966-67. (Figure 1)

The first effective rain fell on November 19, 1967 and the last effective rain on March 18. This resulted in a late fall and an early and dry spring.

Soil moisture reached the permanent wilting point (PWP) on March 25 at Elkhorn and about mid April on the Temblor Rock site. Soil moisture penetrated to somewhere between 12 and 24 inches at the Temblor Rock which was sufficient to meet the moisture profile stored from the previous year. Thus moisture was available to plants to a depth in excess of 60 inches. The resident annuals depleted moisture to the 48 inch depth by early May. Moisture was still available at 60 inches but was not used and was still present in August. By contrast the Elkhorn site had no stored moisture from the previous year and was never wet to a depth of 24 inches in 1967-68. Thus soil moisture was available for approximately 5 months at Temblor Rock and 4 months at Elkhorn.

Fall weather, with its cooler temperatures, did not approach until quite late thus extending warm weather into late October and early November of 1967. Winter then came abruptly and temperatures were very low in December and January. Because of late and insufficient precipitation growing conditions during the winter and spring were favorable for only a short time. The result was a limited growing season because dry, warm weather came earlier than usual.

Temperature data were recorded intensively during the 1967-68 growing season to obtain a better idea of plant growing conditions. Air temperatures were recorded by a hydrothermograph in an official U. S. Weather Bureau weather station at five-foot height. Table 1 gives maximum and minimum temperatures recorded at the Elkhorn Plains site.

II ATRIPLEX STUDIES

During the past two years Jerry Chatterton has worked on several studies with saltbush (*Atriplex polycarpa*) in his research for the Ph.D. degree. Four manuscripts have been prepared for publication out of Jerry's thesis. The titles and abstracts of these papers are as follows:

A. Title: *Atriplex polycarpa*: I. Germination and Growth as effected by Sodium Chloride in Water Cultures. To be submitted to AGRONOMY JOURNAL.

Abstract

Atriplex polycarpa seed was found to have the same general range of salt tolerance during germination as the Australian saltbushes. Germination was severely reduced by solutions having osmotic pressures of +4.2 ATM or more. Growth of established seedlings, although reduced, was not inhibited by solutions having osmotic potentials of +25 ATM. Dry weight of plants in a given

Table No. 1

ELKHORN AIR TEMPERATURES FOR 1967 - 68

(Measured in °F)

Date	Max.	Min.	Date	Max.	Min.	Date	Max.	Min.
12/19	35	25	1/26	52	35	3/2	71	40
20	42	29	27	41	34	3	--	28
21	44		28	48	30	4	53	31
30	63		29	50	28	5	43	31
31	68	39	30	51	34	6	44	38
1/1	63	42	31	53	36	7	46	38
2	50	39	2/1	63	34	8	47	29
3	48	35	2	70	47	9	51	31
4	58	28	3	56	45	10	61	32
5	59	34	4	70	41	11	62	40
6	54	34	5	--	47	12	--	36
7	59	38	6	62	53	3/22	76	43
8	--	33	7	72	56	23	64	40
9	58	37	8	66	41	24	66	44
10	50	41	9	56	44	25	69	45
11	52	34	10	47	42	26	64	47
12	64	34	11	52	36	27	76	46
13	59	34	12	57	38	28	82	49
14	64	36	13	59	38			
15	59	43	14	54	42			
16	46	36	15	57	43			
17	49	30	16	58	39			
18	56	27	25	65	38			
19	58	44	26	72	42			
20	71	34	27	70	42			
21	67	40	28	64	41			
22	66	38	29	65	43			
23	64	47						
24	64	42						
25	60	38	3/1	68	41			

Measured on hydrothermograph housed in weather station C--5 ft. height

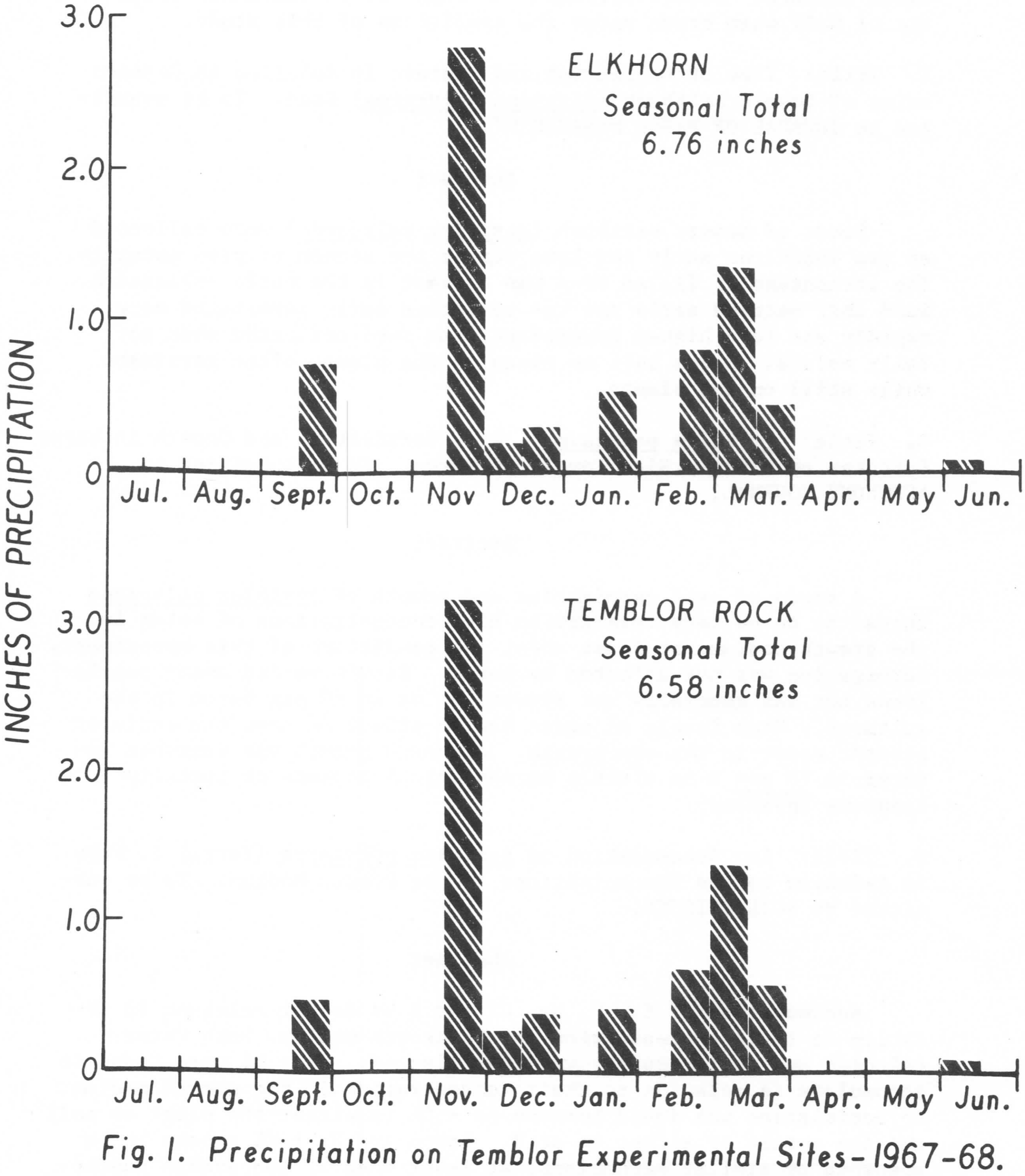


Fig. 1. Precipitation on Temblor Experimental Sites - 1967-68.

NaCl solution varied among populations indicating some populations are more salt tolerant than others. Root growth was somewhat correlated to top growth, however, salt restricted top growth more than root growth resulting in increased root/top ratios as the level of salinity increased. Only the highest concentrations of NaCl used reduced root length. There was no correlation between percent moisture in top growth and the osmotic potential of the water culture. Desert saltbush was found to be extremely tolerant of NaCl when grown under the conditions of this study.

B. Title: Time of Collection and Storage in Relation to Germination of Desert Saltbush (Atriplex polycarpa) Seed. To be submitted to JOURNAL OF RANGE MANAGEMENT.

Abstract

Seeds of desert saltbush (Atriplex polycarpa) were collected at two locations early and late during the season of seed maturity. The percentage of filled seed was highest in the early collection. Seed that matured early and was collected early germinated more rapidly and to a higher percentage than seed collected when not fully mature. Seeds left to ripen on the plants often germinate while still on the plants.

C. Title: Atriplex polycarpa: II. Germination and Growth in Water Cultures containing High Levels of Boron. To be submitted to AGRONOMY JOURNAL.

Abstract

A study of seed germination and growth of Atriplex polycarpa showed it to be very tolerant to high concentrations of boron in the growth medium, at least under the conditions of this experiment. Germination was not affected by boron. Growth varied among populations but was generally not reduced by up to 40 ppm boron in the cultures. High levels of boron had no effect on root/top ratio or percent water in the top growth. Although growth was somewhat reduced in 80 ppm B no visible morphological changes or toxicity symptoms appeared.

D. Title: Ion Accumulation in Atriplex polycarpa (Torr.) S. Wats. in Relation to Ion Concentrations in the Growth Medium. To be submitted to SOIL SCIENCE.

Abstract

Accumulation of Ca, P, Na, Cl and B by desert saltbush in relation to their concentration in the growth medium, both water cultures and native soils, was investigated. Na + Cl were found to accumulate in relation to their concentration in the growth medium. No correlation was found between Na + Cl in either the plant or soil and the uptake of either Ca or P. Boron and Na + Cl appear to be absorbed by similar mechanisms, at least when at comparable concentrations in the growth medium.

E. Saltbush Field Study

Observations of the slatbush disking and topping study north of McKittrick were continued during the 1967-68 growing season. Phil McGoldrick made plantings of Atriplex seeds and observed results of the field treatments of disking and top cutting. (Table 2).

During the year 1967-68, three trips were made to the Temblor area to evaluate the effects of chopping and disking the brush. Test plots were set up and plant counts made in the fall of 1967 and early summer of 1968. Plants were classified by size and apparent vigor. There were 75% dead plants on the drier sites and 30-40% dead plants in the moist gullies. During the test, 10% of the plants in dry areas perished without being disked or chopped. That was apparently due to drought, aging, grazing or from competition with annual forbs and grasses. Chopping killed 50% of the plants in the swales the first season and 75% by the second season, mostly in low vigor classes. On the ridges 30% of the chopped plants were killed. There was an initial flush of growth in the fall after treating which disappeared the second season.

Disking killed 50% of the plants in the swales and 30% on the ridges. There was a marked improvement in vigor in the swales, but only a slight improvement on the ridges. However the improvement continued into the second season both on the ridges and in the gullies. The disking improved 20% of the plants in gullies and 15% of the plants on the ridges. This is a small gain considering that 30-50% of the plants were killed.

These field tests plus the seed germination tests indicate that Atriplex polycarpa is not perpetuating itself under natural conditions. The treatments of disking and chopping do not appear to bring about an immediate marked improvement in stand vigor. Further study, however, appears necessary to follow any changes in the surviving brush initiated by the treatments.

G. Atriplex Forage Production

Reports from the literature and Mr. Chatterton's studies have indicated that Atriplex polycarpa can tolerate extremely high levels of salinity (as high as 50,000 ppm NaCl in nutrient solution). Chatterton has also shown that the same species can tolerate up to 40 ppm boron. In view of these findings, we have begun experimentation at the Moreno Ranch Field Station to determine the feasibility of producing Atriplex for harvested forage, under normal agronomic management conditions. The first seedings were begun in January, 1968 and excellent establishment was achieved for A. polycarpa and A. lentiformis. We experienced great difficulty in establishing four-wing saltbush (A. canescens), and the same was true for A. halimus. Although these seedings have been irrigated with agricultural irrigation water, we believe that the same results could be achieved with brackish water, high-boron water, or on soil too high in boron for production of most agronomic crops. The forage for A. polycarpa and lentiformis has been harvested at 18", 24", and 30" heights during this spring and summer. The fresh weight of forage produced is shown in Table 3. At the time of harvesting, we have analyzed for dry weight, carbohydrate, and nitrogen. It is particularly interesting to note that total soluble carbohydrates are extremely low, whereas nitrogen content and presumably protein is quite high. Thus it would

Table No. 2

Evaluation of saltbush plants subjected to treatments of disking or chopping.

Site Treatment	Date*/	Total Plants	Vigor Rating: Dead 0	1	2	3	Thrifty 4	Living Plants
	EC	121	85	26	9	1	0	36
Ridge	LC	88	56	16	8	7	1	32
Chopped	ET	127	107	0	6	9	5	20
	LT	98	76	8	8	2	3	22
	EC	70	30	12	14	11	0	37
Swale	LC	61	22	6	14	13	6	39
Chopped	ET	64	43	6	5	5	2	18
	LT	48	39	6	3	0	0	9
	EC	141	59	25	35	21	0	81
	LC	124	44	12	28	26	14	70
Swale	ET ||	67	40	9	10	6	2	27
Disked	ET ⊥	102	68	8	19	11	0	34
	LT ||	40	12	4	8	2	14	28
	LT ⊥	60	16	16	6	2	20	44
	EC	121	85	26	9	1	0	36
	LC	88	56	16	8	7	1	32
Ridge	ET ⊥	44	20	7	11	6	0	24
Disked	ET ||	62	45	7	5	4	1	17
	LT ⊥	38	14	4	10	10	4	28
	LT ||	32	12	0	12	4	4	20

*/Early control: EC; Late control: LC; Early test: ET (October 1967); Late test: LT (July 1968).

|| : parallel to furrows.

⊥ : perpendicular to furrows.

Table No. 3.

Yield and analytical data for two saltbush species growing under intensive management.

Harvest Date	Yield (lbs/A fresh wt.)	% Dry Matter	% N	% Ash	% Soluble CHO
		<u>Atriplex polycarpa</u>			
6-19-68	5445	29.2	2.78	10.9 stems	2.20
				20.6 leaves	
7-17-68	11715	30.4	2.73	6.4 stems	2.22
				21.7 leaves	
8-21-68	13861	42.4	--	--	2.49
		<u>Atriplex lentiformis</u>			
6-19-68	9405	27.7	2.54	13.2 stems	2.93
				30.1 leaves	
7-17-68	18480	33.2	2.62	5.7 stems	2.48
				29.2 leaves	
8-21-68	20385	42.9	--	--	2.72

appear that Atriplex forage would need to be supplemented with a high-carbohydrate feed in order to make a balanced ration. Such forced rotational grazing has been tried experimentally in South Africa using saltbush and prickly pear cactus.

It remains to be seen whether saltbush may be used as a gain diet for cattle, but its use for sheep nutrition is well documented in the literature.

Our plans for next year call for continued cutting of saltbush regrowth, studying rate of regeneration under limited irrigation.

G. Atriplex Morphology and Drought Tolerance

During the past year considerable progress has been made in the study of saltbush anatomy and morphology, with particular emphasis on leaf structure and drought tolerance. Unlike many xerophytic plants (which often have thick cuticles, heavy wax deposits, and sunken stomata), saltbush is characterized by a single-layered epidermis with essentially no cuticle. Protruding from the epidermis is a dense layer of large, baloon-like, highly vacuolated cells on long stalks. These trichomes appear to form a protective covering over the epidermal surface, and as they age, burst leaving an encrustation of salt crystals on the leaf surface. This extremely saline solution creates a high osmotic pressure within the cell and apparently imparts the essential drought-tolerant qualities to the plant.

Unlike the salt cedar (Tamarix) and other sodium accumulators, there is no well-developed vascular system in saltbush and no salt glands to serve as an "exhaust pump" for the salts. Instead, the salt seems to accumulate in the trichomes which eventually burst and leave a crystalline litter on the leaf surface. Most of this crystalline accumulation appears to be sodium oxalate, which may be unpalatable and even toxic to animals in high concentration.

H. The Biosynthesis of Oxalate in Atriplex

Since sodium oxalate appears to accumulate in high concentrations in saltbush, we felt that it would be desirable to study the synthesis of oxalic acid and try to determine exactly why it happens. Mr. Mozafar, a graduate student from Iran, is presently conducting biochemical research in oxalate metabolism. He has found that rates of catalase and perosidase activity are extremely high. Both of these enzymes are important in the pathway of oxalic acid synthesis. He will be studying the influence of moisture stress, salinity, and temperature upon levels of enzymes, and look for isozymes which may operate under differing conditions.

III SPECIES ADAPTATION

A. 1966-67 Trials

The trials established in the fall of 1966 (reported on pages 12-16 of 1966-67 Temblor Range Research) were sampled again in March and May of 1968. At the elkhorn site only Geraldton subclover had a satisfactory stand on March 10. (Table No. 4) Geraldon subclover, Kondinin rose clover, Cyprus

Table No. 4

Plant introductions in 1966-67 species adaptation trials at Elkhorn and Temblor Rock - second growing season.

	ELKHORN		TEMBLOR ROCK	
	Stand March 10, 1968	Maturity stage May 2	Stand March 10, 1968	Maturity stage May 2
SUBCLOVER VARIETIES (*Trifolium subterraneum* L.)				
Tallarook	1	dry - no seed	1	dry - no seed
Mt. Barker	1	dry - no seed	0	
Bacchus Marsh	1	dry - no seed		
Woogenellup	2	dry - no seed	2	dry - no seed
Clare	1	dry - no seed	1	dry - no seed
Yarloop	2	dry - no seed	1	dry - no seed
Dwalganup	3	dry - no seed	3	dry - seed ripe
Geraldton	9	dry - some ripe seed	4	dry - seed ripe
Dinninup	1	dry - no seed	1	dry - no seed
ROSE CLOVER VARIETIES (*Trifolium hirtum* All.)				
Wilton (Calif. Cert.)	1	dry - no seed	2	dry - no seed
P.I. 170821	2	dry - no seed	4	dry - seed green
Kondinin	2	dry - few ripe seeds	9	50 % dry - early ripe
Cyprus	1	dry - few ripe seeds	8	dry - seed ripe
Hykon	3	dry - no seed	9	75 % dry - seed green
Olympus	1	dry - few ripe seeds	4	dry - seed ripe
Sirint	1	dry - no seed	6	dry - seed ripe
Th 52	1	dry - no seed	5	dry - no seed
S-6	1	dry - no seed	8	dry - no seed

Table No. 4 (con't.)

	ELKHORN		TEMBLOR ROCK	
	Stand March 10, 1968	Maturity stage May 2	Stand March 10, 1968	Maturity stage May 2
MEDICS (medicago spp.)				
Bur clover (M. hispida Gaertn.)	1	dry - no seed	8	dry - seed ripe
Black medic (M. lupulina L.)	0		1	dry - no seed
173 barrel medic (M. tribuloides Desr.)	1	dry - no seed	8	dry - green seed
Cyprus barrel medic (M. tribuloides Desr.)	1	dry - no seed	2	dry - seed ripe
MISCELLANEOUS LEGUMES				
Dixie crimson clover (T. incarnatum L.)	1	dry - no seed	1	no seed
Purple clover (T. purpureum Loisel.)	1	dry - no seed	2	green - full bloom
Beenong cup clover (T. cherleri L.)	1	dry - no seed	3	dry - seed ripe
Yamina cup clover (T. cherleri L.)	1	dry - no seed	3	dry - seed ripe
Hairy canary clover (Dorycnium hirsutum (L.) Ser.)	0		0	
Lana woollypod vetch (Vicia dasycarpa Ten.)	0		0	
Auburn woolypod vetch (Vicia dasycarpa Ten.)	0		0	
ANNUAL GRASSES				
Gaudin ryegrass (Lolium gaudini Parl.)	3	dry	6	green - anthesis

Table No. 4 (cont'd.)

	ELKHORN		TEMBLOR ROCK	
	Stand March 10, 1968	Maturity stage May 2	Stand March 10, 1968	Maturity stage May 2
PERENNIAL GRASSES				
Hardinggrass (*Phalaris tuberosa* var. *stenoptera* (Hack.) Hitchc.)	6	25% green - vegetative	5	50% green - vegetative
Palestine orchardgrass (*Dactylis glomerata* L.)	7	56% green - vegetative	5	50% green - vegetative
Davis slender wheatgrass (*Agropyron trachycaulum* (Link.) Malte var. *major*	9	60% green - vegetative	4	green - boot
Kangaroo Valley ryegrass (*Lolium perenne* L.)	0		0	

* Stand was rated on a 1-10 basis, 1 being poor and 10 excellent. Data are means of three replications.

rose clover, and Olympus rose clover were the only legume varieties to make seed.

On the better growing conditions present at Temblor Rock there were good stands of Kondinin rose clover, Cyprus rose clover, Hykon rose clover, and S-6 rose clover. However only Sirint, Olympus, Cyprus, Kondinin, and possibly P.I. 170821 and Hykon set seed in this dry year so the stands next year may be somewhat different.

None of the subclovers produced a satisfactory stand at Temblor Rock. Dwalganup and Geraldton were the best and also were the only ones to set seed. Both bur clover and 173 barrel medic produced excellent stands, however 173 barrel medic seed was still green on May 1 and may not have ripened. Bur clover matured seed.

Three of the four perennial grasses (Hardinggrass, Palestine orchardgrass, and Davis slender wheatgrass) planted in 1966 survived into the second year at both sites. The stands at the drier Elkhorn site were equal to or better than the stands at Temblor Rock.

Nearly all of the varieties produced excellent stands in the wet conditions of the first spring, and most of them set seed. The vastly different results this year point out the need to continue such a trial over a number of years before valid seeding recommendations can be determined.

B. 1967-68 Trials

Ninety-three forage varieties were planted at each experimental site. The soil was furrowed in March of 1967 and a weed free condition maintained by spraying with paraquat in late March and again in April after spring rains started another crop of weeds. It was necessary to spray again in July with weed oil to control turkey mullein and annual spurge.

Replicated plantings of four 20-foot rows, 24 inches apart, were made in the fall of 1967 except some shrubs which were planted in the spring of 1968. The grasses were planted on November 8, -- before the first rain. Legumes were planted on December 19 in moist soil. All legumes were pellet inoculated with the proper Rhizobium bacteria before planting.

A list of the 93 forage varieties and the stand as rated on May 2, 1968 is shown in table No. 5. The stand figures are important in that they indicate if the seed sprouted and seedlings were obtained. However in this dry year it is obvious that many may not become truly established. Some perennials will not survive the dry summer and many of the annual legumes were not successful in setting seed. Again the trial will need to be followed for several years to determine if any of these plants will have a place.

Many of the seedlings remained green long after the adjacent range had dried up, indicating that we were successful in retaining some moisture in 1966-67 by fallowing. In general the grasses got a better start than the legumes. This may be due to the earlier planting date which may be critical in such a short growing season. None of the shrub seed was observed to sprout

Weeds were a problem on the Temblor Rock site. Fiddleneck (Amsinckia tessellata Gray) was the most serious. These were sprayed with

Table No. 5

TEMBLOR RANGE VARIETY TRIAL

			Stand* May 2, 1968	
	Grasses - Planted November 8, 1967		Elkhorn	Temblor Rock
1.	Avena sterilis T.O. 3722		8	5
2.	Agropyron desertorum	Nordan crested wheatgrass	2	3
3.	" " A-13043		10	10
4.	" " 2 clone synthetic 114X117 - from Mandan. S.D.		5	--
5.	Agropyron desertorum 117X114 from Mandan S.D.		10	--
6.	Agropyron elongatum	Alkar tall wheatgrass	8	5
7.	" "	Jose tall wheatgrass	10	10
8.	" "	Largo tall wheatgrass	10	5
9.	Agropyron inerme	Whitmar beardless wheatgrass	10	10
10.	Agropyron intermedium	Amur intermediate wheatgrass	10	3
11.	" "	Greenar intermediate wheatgrass	10	6
12.	" " A-12496		8	3
13.	" "	Oahe intermediate wheatgrass	7	4
14.	Agropyron sibiricum P1-141-62	Siberian wheatgrass	4	1
15.	Agropyron smithii P-727	Western wheatgrass	10	5
16.	Agropyron spicatum P-737	Bluebunch wheatgrass	4	7
17.	Agropyron trachycaulum var. majus T.O. 2490	Davis slender wheatgrass	10	8
18.	Agropyron tricophorum	Luna pubescent wheatgrass	10	6
19.	" "	Topar pubescent wheatgrass	10	8
20.	" "	Trigo pubescent wheatgrass	10	8
21.	Bromus auleticus T.O. 3694		1	1
22.	Bromus carinatus	Cucamonga brome	10	10
23.	Bromus erectus T.O. 3893	Erect brome	10	5
24.	" " T.O. 2611	Erect brome	10	8

Table No. 5 (con't.)

			Stand*	
			May 2, 1968	
			Elkhorn	Temblor Rock
25.	Bromusmollis	Blando brome	10	10
26.	Bromus scoparius T.O. 3546		10	7
27.	Bromus severtzovii T.O. 4012		10	10
28.	Dactylis glomerata T.O. 1638	Palestine orchardgrass	10	10
29.	Elymus cinereus C-43	Basin wildrye	6	6
30.	" " P-5797	Basin Wildrye	10	5
31.	Elymus condensatus - Clones from Pleasanton PMC	Giant wildrye - P-10426 Santa Paula Nursery	5	Dead
32.	Elymus junceus	Russian wildrye	1	1
33.	Elymus triticoides - Clones Pleasanton PMC	Beardless wildrye - P1-249-50 Firebaugh, California	10	10
34.	Festuca arizonica NM-5		2	5
35.	Festuca ovina P-274	Sheep fescue	8	10
36.	Festuca ovina var. duriuscula	Durar hard fescue	10	10
37.	Lolium gaudini T.O. 3023	Gaudin ryegrass	10	10
38.	Lolium rigidum	Wimmera ryegrass 62	10	10
39.	Orozopsis holciformis T.O. 3904		5	2
40.	Orozopsis hymenoides C-42	Indian ricegrass	10	5
41.	" " NM-15	Indian ricegrass	3	7
42.	Orozopsis miliacea	Smilo	1	1
43.	Orozopsis miliacea T.O. 3759		1	--
44.	Phalaris tuberosa var. stenoptera	Hardinggrass	7	5
45.	Poa ampla	Sherman big bluegrass	8	10
46.	Poa ampla P-8903	Albion big bluegrass	10	10
47.	Poa bulbosa P-4874	Bulbous bluegrass	5	10
48.	Poa scabrella P1-112-55	Malpais bluegrass	1	10

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Table No. 5 (con't)

Legumes - Planted December 19, 1967		Inoculated Dec. 14	Type	Stand* May 2, 1968 Elkhorn	Stand* May 2, 1968 Temblor Rock
51. Astragalus cicer		Cicar cicer milkvetch	Astragalus	4	2
52. Astragalus falcatus	P-487		"	3	2
53. Biserrula pelecinus	T.O. 3764		None	1	2
54. Dorycnium hirsutum	P-13229	Hairy canary clover	"	3	10
55. Medicago hispida		Bur clover	A	6	2
56. Medicago litteralis	CR 712		A	7	10
57. Medicago media		Rambler alfalfa	A	5	10
58. Medicago scutellata	T.O. 3428		A	2	1
59. Medicago tribuloides		173 Barrel medic	A	8	7
60. " "		Cyprus barrel medic	A	4	5
61. Melilotus alba annua	A-15233		A	4	1
62. Onobrychis sativa	T.O. 4241		Sainfoin	3	5
63. Onobrychis viciafolia		Onar sainfoin	"	7	1
64. Trifolium arvense	T.O. 2629		Special	1	1
65. Trifolium cherleri		Yamina cup clover	for rose,	3	5
66. " "		Beenong cup clover	sub, and	3	7
67. Trifolium hirtum		Kondinin rose clover	crimson.	6	6
68. " "		Cyprus rose cover	↓	4	5
69. " "		Hykon rose clover	↓	6	8
70. " "		Olympus rose clover	↓	6	8
71. " "		Sirint rose clover	↓	5	5
72. Trifolium resupinatum	T.O. 2876		↓	1	1
73. Trifolium subterraneum		Mt. Barker subclover	↓	2	1
74. " "		Woogenellup subclover	↓	2	1
75. " "		Clare subclover	↓	2	1
76. " "		Yarloop subclover	↓	2	1
77. " "		Dwalganup subclover	↓	1	4
78. " "		Geraldton subclover	↓	3	1
79. " "		Dinninup subclover	↓	1	1

Table No. 5 (con't.)

			Stand* May 2, 1968 Elkhorn	Stand* May 2, 1968 Temblor Rock
80. <u>Vicia</u> <u>dasycarpa</u>	Lana woolypod vetch	C	7	5
**********				
<u>Shrubs - Planted December 19, 1967</u>				
81. <u>Atriplex</u> <u>canescens</u> A-16831 Lot 4506 25 miles S Winslow Arizona	Four-winged saltbush			
82. <u>Atriplex</u> <u>canescens</u> A-16652 Lot 4791 Los Lunas New Mexico	Four-winged saltbush		0	0
83. <u>Atriplex</u> <u>canescens</u> A-16805 Lot 4458 Santa Rita Expt. R. - Arizona	Four-winged saltbush			
84. <u>Purshia</u> <u>tridentata</u> Timber Mt. Modoc Co.	Bitterbrush			
85. <u>Atriplex</u> <u>canescens</u> from Carl Twisselman				
87. <u>Atriplex</u> <u>polycarpa</u> from Carl Twisselman				
**********				
<u>Shrubs - Planted Spring, 1968</u>				
88. <u>Atriplex</u> <u>lentiformis</u> from Carl Twisselman				
89. <u>Atriplex</u> <u>polycarpa</u> gathered from guzzler on Top of Temblors on 1/12/68				
90. <u>Isomeris</u> <u>abrorea</u> Pozo Creek - Kern Co. CDF&G 1967				

Table No. 5 (con't.)

	Stand* May 2, 1968 Elkhorn	Stand* May 2, 1968 Temblor Rock
91. <u>Isomeris</u> <u>arborea</u> T.O. 3826 Los Angeles County 1962	0	0
92. <u>Purshia</u> <u>tridentata</u> BC-48 California-Nevada County June, 1964	↓	↓
93. <u>Prosopis</u> <u>tamaruga</u> Tamarago-Chile	↓	↓

* Stand rated 1-10; 1 = none, 10 = excellent.

bromoxyanil on the grass trial, but the fiddleneck was large when sprayed and had removed much moisture. No spraying was attempted on the legume or shrub trials because of possible damage to the planted species.

An attempt was made to control the rodents on these areas since the fall of 1966. Some damage was observed in the early summer of 1968 -- mostly clipping off the grasses. A subsequent poinsoning seems to have them under control.

IV SOIL FERTILITY

On the basis of the greenhouse soil fertility test reported last year a field trial was established in the fall of 1967 at the Temblor Rock site. A field site was rototilled after the first rains and seeded to a mixture of freshly pelleted legume seed of the following mix:

5 parts Sirint rose clover
3 parts Hykon rose clover
2 parts Kondinin rose clover
4 parts Clare subclover
4 parts 173 Barrel medic

This mixture was seeded at the rate of 290 lbs/acre to insure a good stand which is necessary to measure the expected fertilizer response. However growth of the clovers was minimal under the dry conditions and no fertilizer response was evident.

The fertilizer treatments were sulfur at 400 lb/acre applied as gypsum and zinc as zinc nitrate solution. These were applied to 10 x 15 ft. treatments singly and in combination and compared to a non-fertilized check. This trial will be continued in hopes of measuring a response on a better growing year.

V ASPHALT MULCHING STUDY

Asphalt mulching has been used previously for raising soil temperatures during germination and subsequent seedling growth. In all of the tests the asphalt was applied in the spring of the year and results were generally favorable. In no case was asphalt applied in winter conditions.

Most of the published information on plastic and asphalt give reports of studies conducted on tilled soil. Chudnowski stated that tillage increases the heat capacity of soils above untilled soil by as much as five times. In another study Bement et al. in Colorado studied grass establishment on untilled soil in the early spring and again, found an improvement in temperature for establishment of warm season grasses.

Materials and Methods

An experiment was initiated to test the effects of asphalt mulch on the establishment of three annual and one perennial species in the Temblor Range area. The four species used were Barrel Medic, Sirint Rose Clover, Davis Slender Wheatgrass and Wimmera Ryegrass.

The asphalt mulch treatments were applied at 0, 6, 9 and 12 inches in width across the middle of the seedling rows. The asphalt treatments were applied at two times, first on November 16 and second on December 19, 1967. At the first planting date, plots were established at the Rock Plot and at the Elkhorn Plains stations. Because of slippery roads asphalt mulch could not be sprayed at the Rock Plot on the second planting date.

The seed was drilled 0.5 inches with a double disk opener. Following seeding the previously installed Bouyoucous moisture resistance blocks, thermistors, recording thermograph leads, and thermocouples were set in place and the asphalt emulsion was applied. The asphalt treatments were randomly applied on each seed row with four replications at each site. It was expected that there would be no interaction of one seed row on the next as the rows were 22 inches apart. A paraquat application was used on the second planting at the Elkhorn Plain site to rid the seeded species of plant competition from resident species. After the planting and asphalt applications the sites were checked on a monthly basis.

Establishment counts were taken during the latter part of the growing season. Of the 15 ft. of row, four 1-ft. sections of each row were measured. A device was constructed to measure 1 ft. of row and to divide this foot of row into four equal sections, 3 inches each. For establishment, the 1 ft. marker was set along the seed row and if a plant appeared in a 3-inch section then that indicated establishment in the 3-inch length. For each treatment then there were sixteen 3-inch sections measured. A percentage establishment was recorded from these sixteen lengths.

On March 28, 1968 all the plots that could be harvested were harvested. The plants were brought back to Riverside and oven dry weights were later recorded. The harvested material was cut from 4 ft. of row. Four 1-ft. sections were cut at random from each 15-ft. treatment row.

Results

The soil temperature data recorded indicate that there were no real differences in soil temperatures between treatments and control. Also there were no soil temperature effects from the asphalt mulching at 1/2-inch below the soil surface.

Soil moisture data were taken in all three tests. There was an extreme amount of variability between replications and this overshadowed any differences between treatments. From the data it was deduced that the asphalt neither impeded the entry of precipitation nor loss of soil moisture by evaporation.

There were, however, obvious differences between the first and second plantings at the Elkhorn plots. Moisture was retained longer in the soil under the second planting treatment because the competing plants that had previously germinated and emerged were killed by the paraquat application. However, by March 30, 1968 the moisture content of the two plots was the same.

There was no emergence of Davis Slender Wheatgrass in any of the plots. The two legumes had the best establishment records. Wimmera Ryegrass emergence at the Rock Plot was very poor and sporadic. Ryegrass plants also showed very poor growth. The first planting of ryegrass at the Elkhorn plot areas consisted of many seedlings but the growth of these seedlings was very poor.

The ryegrass in the second planting at the Elkhorn showed a very erratic establishment, but the plants were quite large and their growth was surprisingly good. Wimmera Ryegrass is native to the arid areas of Australia. However, it is questionable whether the asphalt was any help on its establishment and growth.

Establishment data were confined to the two legumes in the tests as they showed more uniform results. There were, however, no significant differences between treatments and control in the establishment of these two species by the use of asphalt mulch. Barrel Medic appeared to have a greater number of seedlings with emulsion at a later date and at the colder Rock plot site.

No harvest data were taken for either Davis Slender Wheatgrass or Wimmera Ryegrass. Harvests were made of the two legumes. Statistical analysis of the original data show no significant differences between treatments. However, asphalt emulsion appeared to give a slight improvement in the production of Barrel Medic.

Discussion

Probably the most limiting factor of the above study was rainfall. Because of little rainfall during the growing season, the results are very limited. Further study would have to be done to make more accurate conclusions of the range use of asphalt mulching for fall and winter seeding.

VI SEEDING TECHNIQUES

An experiment at Elkhorn site compared various weed control treatments prior to planting. These included a fallow from both soil active herbicides (atrazine) and cultivation and a contact weed killer (paraquat). The atrazine was applied at 1 lb. and 2 lb. in the fall of 1966. The paraquat treatment was first applied on March 1, 1967, and reapplied on April 26 after spring rains started another weed crop. The cultivated fallow was rototilled on March 1, 1967 and again on April 26. Other treatments at the time of seeding included rototilling and spraying with paraquat after the resident vegetation sprouted. These were compared to seeding without any preparation or "check". Soil moisture was measured in all treatments at 12, 24, and 36 inches by gypsum electrical resistance blocks.

Seeding included 2 dates. The first was November 8 which was before the opening rain and the second on December 20 -- after the resident vegetation had germinated. Seeding was done both in deep furrows (3 inches deep and 10 inches wide) and with no furrows at both dates. Sirint rose clover, 173 barrel medic, Luna pubescent wheatgrass, and Davis slender wheatgrass were seeded in separate rows in all treatments, dates, and furrow types.

Varying amounts of additional moisture were made available by the different weed control treatments. (Figure 2) By far the greatest amount of available moisture was on the 2 lb. of atrazine treatment. Only in the 1 and 2 lb. atrazine treatments was any moisture stored at the 24 or 36 inch level. The one lb. rate did not show moisture storage during this period, but it was the only other treatment which showed any moisture at 24 inches during the winter of the following year indicating that there was some storage someplace in the profile.

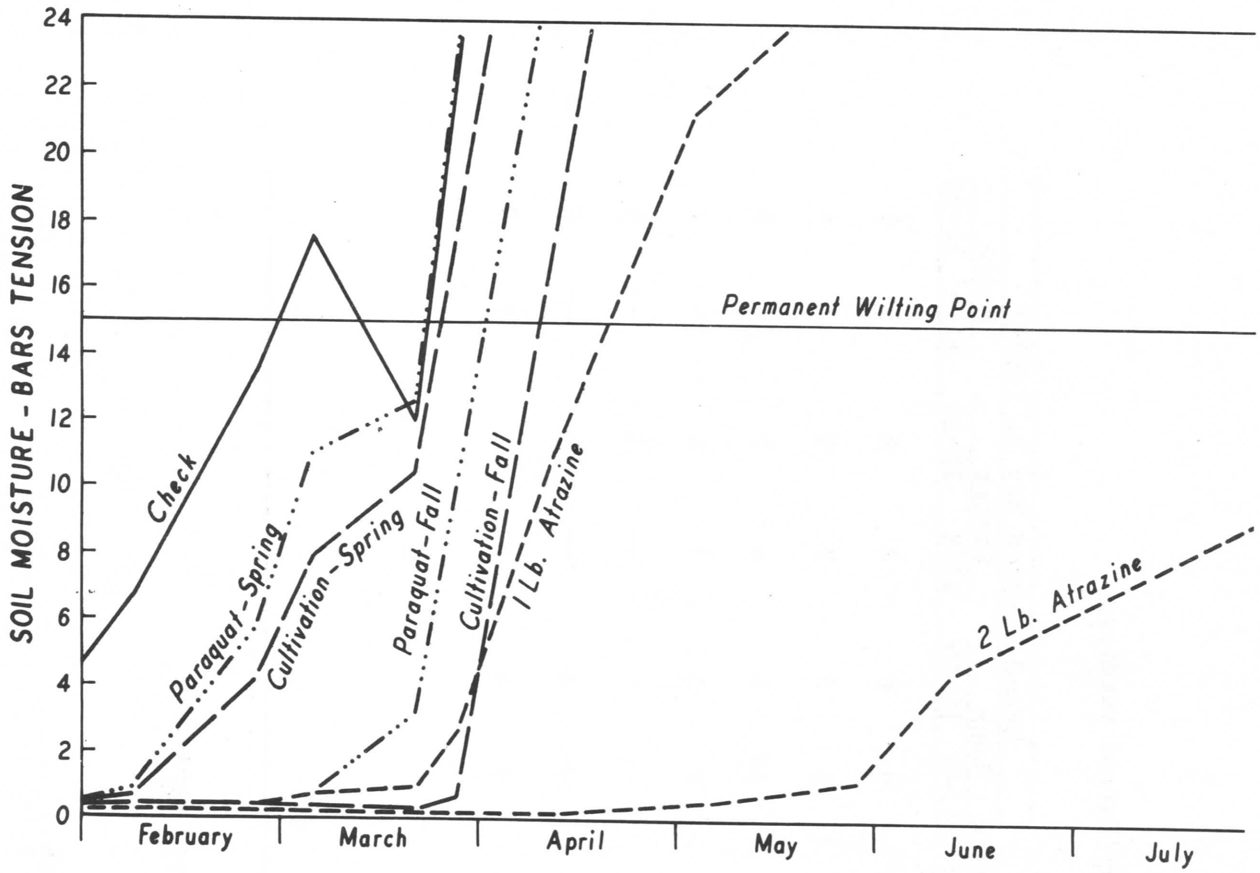

Figure 2. Soil moisture storage at 12 inches with various weed control practices.

Moisture storage should have been better on all fallow treatments if it were not for a summer crop of annual spurge (Euphorbia ocellata D. & H.) and turkey mullein (Eremocarpus setigerus Benth.). These were praticularly bad on the spring paraquat and spring cultivation treatments. It appears summer weed control will be necessary on fallow treatments with the possible exception of soil active herbicides.

The moisture available at 12 inches through the spring of 1968 for the seven treatments is shown in figure 2. The 1 lb. atrazine treatment had moisture available a full 28 days after the check plot reached the permanent wilting point, while the 2 lb. rate had moisture through July.

The effect of the furrows was most striking. There was essentially no stand establishment of any of the species on the seedings without furrows. However in the furrows many of the treatments produced fair stands. (Table 6) Seedling stands of Luna wheatgrass were fair to good on all treatments. However this perennial will need to be sampled again in the winter of 1968-69 to measure which seedlings became truely established. The amount of

Davis slender wheatgrass did not establish well in any treatment. Further tests in the laboratory showed the seed to have high potential germination but germination was delayed. Under laboratory conditions Luna with total potential germination of 94% germinated 91% in 6 days, while Davis slender wheatgrass germinated only 4% of a total potential of 86%. Thus under the very dry conditions on the Temblor Range the

Table No. 6

Weed control and stand establishment in deep furrow seedings.

		1-10 Weed Control* 3/5/68	Dominant Weed Species*** 5/2/68	Stand - rated May 2, 1968**					
				Luna		Sirint		Medic	
				11-8	12-20	11-8	12-20	11-8	12-20
1	2# atrazine	5.0	FS	9	6	2	2	5	6
2	1# atrazine	8.0	S	6	4	2	2	2	4
3	paraquat fallow	1.2	S	10	6	4	5	4	5
4	cultivated fallow	5.2	F	9	5	3	6	5	7
5	paraquat at seeding	6.8	S	--	6	--	5	--	6
6	cultivated at seeding	9.0	BF	--	4	--	5	--	7
7	check	1.0	FB	9	6	3	5	4	5
	LSD .05	0.9							
	.01	1.3							

* 1 is no weed control, 10 = excellent weed control.

** 1 is no stand, 10 = excellent stand.

*** B = red brome, F = filaree, S = Schismus seed of Davis slender wheatgrass was not wet for a long enough period to germinate.

Both legumes produced fair stands on most treatments in deep furrows, but again did not establish on the surface sowings. Even the check treatments produced good plants but they produced little if any seed. The effect of the various weed control treatments should be reflected in stand differences in the second year due to the differences in seed production in the first growing season.

In general legume stands were improved by seeding after it rained rather than before. This is probably due to the higher survival rate of the Rhizobium bacteria. Although both seedings were pellet inoculated immediately before seeding the survival would be highest when planted in moist soil.

By contrast Luna wheatgrass stands were better from the earlier seeding date. This can be explained by the warmer termperatures during germination plus the longer growing season resulting from the earlier germination.

The soil moisture and stands of seeded species will be followed into the second growing season.

A second trial of similar design was established at an adjacent location in the fall of 1967. Weeds on the fallow treatments were few because of the dry spring, but these were controlled. This experiment will be seeded in the fall of 1968. Again four forage varieties will be planted separately in surface and deep furrow plantings.

VII MISCELLANEOUS EXPERIMENTS

As mentioned earlier the results of furrow seeding were far superior to surface drilling. In anticipation of such a difference a number of measurements were made of the environment around and beneath the seed under weed free conditions

Soil moisture was measured at 1, 3, and 6 inches beneath the surface and the bottom of the furrow. Soil moisture in the surface inch is limited to only a short period after each rain. However the one inch in the bottom of the furrow remains wet much longer than the surface one inch and was responsible for the better germination in the furrows. The 3 and 6 inch depths were also wet much later in the season -- up to one month. (Figure 3) This extra moisture explains the better stands present in the May sample in the furrows as discussed earlier.

Soil temperatures were only slightly affected by the furrow. Furrow temperatures were colder than surface from 7 - 11 AM, warmer from 11 AM - 1 PM, and slightly cooler from 3 to 5 PM. This is if the sun is shining or there is no wind (Figure 4).

On sunny days with the wind blowing there may be differences similar to the above if the wind blows across the furrows. However if the wind blows the length of the furrows there is no difference. On overcast days there is no difference between furrows and surface.

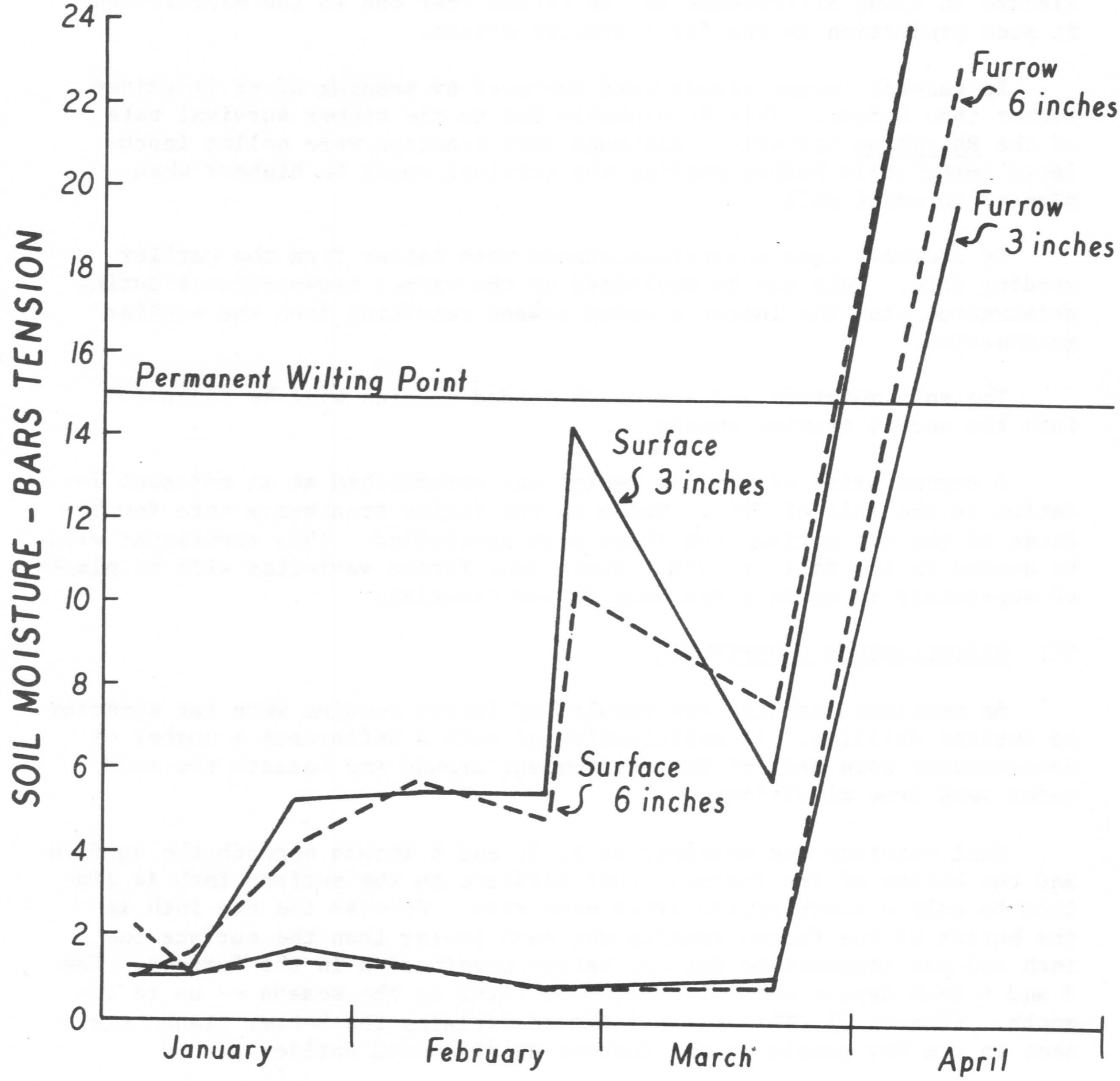

Figure 3. Soil moisture availibility in surface vs deep furrow plantings.

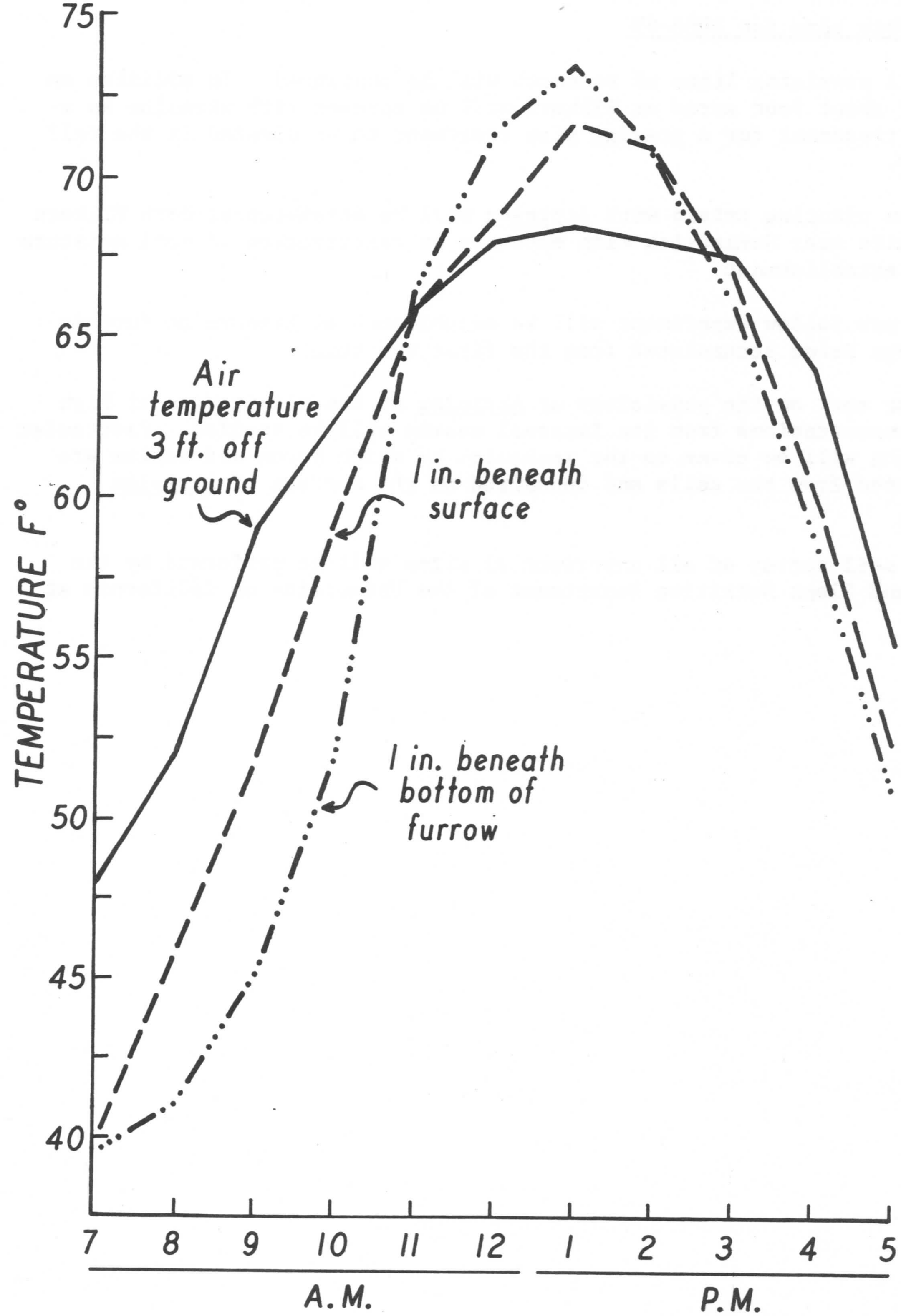

Figure 4. Temperatures in furrows vs surface seedings during daylight hours.

VIII Work plan for 1968-69

All promising lines of research will be continued. In addition an area of about four acres at Elkhorn will be sprayed with atrazine as a fallow treatment for a grazing size treatment to be planted in the fall of 1969.

New planting trials with *Atriplex* will be attempted at both Elkhorn and a site near McKittrick with emphasis on conservation of soil moisture during establishment.

A new fallow experiment will be established at Elkhorn to further knowledge being accumulated from the first two trials.

The work on the physiology of *Atriplex* in the elimination of high salt concentrations from its internal system will be studied. Particular attention will be given to the mechanism by which boron and sodium are eliminated from the cells and deposited on the surface of *Atriplex* leaves.

A soil survey of all experimental sites will be performed by the Soils and Plant Nutrition Department of the University of California at Davis.