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Dust Storms

Observations of peat dust storms were made during the calendar year 1956. The general pattern of these storms disclosed nothing new and the description under the paragraph "Dust Storms" p.p. 7-8 in the 1955 progress report dated January 13, 1956, adequately describes the storms observed during 1956. Thirty-five dust storms from March to December were observed and recorded. As in 1955, they varied from severe and general to minor and localized. The description of each storm was studied and a relative rating according to severity given to each. The five categories were: very severe, severe, moderate, mild, very mild. Similarly, the dust storm descriptions for 1955 were analyzed and each put into one of three categories: severe, moderate, mild. It should be noted that the lack of the categories "very severe," and "very mild" for 1955 does not imply there were no storms of these magnitudes in 1955, based on the 1956 scale. Rather, descriptions were inadequate to divide the storms into more than three relative classes. The storms for both years were further separated into storms caused by generally westerly winds hitting Stockton and/or Lodi and storms caused by generally northerly winds which largely by-passed Stockton and Lodi and which may or may not have hit Tracy.

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Westerly dust storms hitting Stockton and/or Lodi:

Number of storms by month

	1955	1956
January	(no data)	0
February	(no data)	0
March	(no data)	2
April	3	2
May	6	9
June	11	9
July	3	3
August	0	6
September	3	0
October	1	0
November	0	0
December	0	0
Total	27	31

Number of storms by half-months for May and June

	1955	1956
May 1-15	1	1
May 16-31	5	8
June 1-15	5	7
June 16-30	6	2

Talley of storms by severity:

(Note - In ascribing degrees of severity to storms, if dust had a given severity in one local section of a city but the bulk of the city were subjected to much milder dust, the storm as a whole was given a rating one step less severe than occurred in the local area.)

Number of storms by severity

1955	
Severe	4
Moderate	8
Mild	15

1956	
Very severe	2
Severe	2
Moderate	6
Mild	14
Very mild	7

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Severity by months:

Number of storms

	1955			1956				
	Severe	Moderate	Mild	V. Severe	Severe	Moderate	Mild	V. Mild
March							2	
April	1	2					1	1
May		1	5	1	1		4	3
June	3	4	4	1	1	4	2	1
July		1	2			1	2	
August						1	3	2
September			3					
October			1					

Several points are to be noted from the above tabulations:

1) The fact that there were more storms recorded in 1956 does not mean that there were actually more storms in 1956 than in 1955 or that 1956 was the dustier year. Since whether a storm occurred or not and how severe it was, was a purely subjective estimate and since no precise definitions of a storm were used (and would probably be most difficult if not impossible to set up and use) and judging from the written notes for the two years, it is certain that the standards for the two years varied considerably. This change of standards for judging dust storms from year to year seems inevitable because of the different pattern of field work from one year to another (hence the location of observation during storm), the long space of time between one dust season and the next, and the constantly accumulating familiarity with dust storms. The general consensus of the public locally seems to be that 1956 was considerably less dusty than 1955 but that the 1956 summer was more dusty than the 1955 summer.

The importance and value of the above tables lies in comparing the patterns of dust storms, one year with another. It is felt that the standard of dust storm evaluation within any one year was sufficiently uniform to permit valid and useful patterns of dust storms through the year.

2) During the past two years, more storms hit Stockton and/or Lodi during the months of May and June than in all the other months combined. Further, practically all of the storms for those two months came after May 15.

3) In each year, one late summer or early fall month had a considerable number of storms.

4) Of the westerly storms, there are more mild (and very mild) storms than there are moderate and severe (and very severe) storms combined. Also there are fewer severe (and very severe) storms than there are moderate ones. An elimination of the present mild storms and the moderating of would-be severe storms to a milder category would help the past dust problem in Stockton and Lodi greatly.

5) Seven out of eight of the severe and very severe westerly storms for the two years occurred during the months of May and June and after May 15. Also, a majority of the moderate storms also occurred during these months (and after May 15).

Northerly dust storms generally by-passing Stockton and Lodi:

There were only 3 storms in this category for 1955 and 4 in 1956.

Dates:

Storm category	1955	1956
Severe	4/4, 11/11	3/11, 12/21
Moderate	5/31	2/16, 3/27
Mild		

Six out of the seven storms of this category occurred during the winter or early spring and were all moderate to severe. These storms were caused by strong NNW or N winds.

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Dust Collecting Activities

On March 10, 1956 the Research Appliance Corp. Automatic Dust and Smoke Sampler was put into operation on the roof of a cooperator's home at 2529 W. Euclid, Stockton. This is the same location as in 1955. The collector was operated continuously until December 4, 1956 when it was removed for the winter. The optical density measurements of the paper tape spots have not yet been completed and tabulated. As was noticed last year, there were several occasions of dense black spots on the tape at times when there could have been virtually no dust in the air. These spots were examined microscopically and were found to have a different appearance than spots known to be caused by dust. It is hoped that it will be possible to separate dust spots from smoke spots in order to get a quantitative index of dustiness in town to compare with the subjective tabulations shown in the previous section of this report and with delta weather station information on wind direction and velocity.

The Staplex and continuous flow impinger samplers tried out last year were not used in 1956. Since windiness and dust storms come up with little advance warning, the use of short time integrating collectors requiring auxiliary equipment (such as generators, vacuum pumps, cables) in the field appear to have only limited usefulness. For this reason it seemed desirable to design simple, inexpensive dust collectors which could be put out in fields for extended periods of time.

A number of designs using impinger principles were made up from #2½ tin cans and from 24" lengths of 4" galvanized stovepipe. The tin can models all had an inverted half-can on top to act as the impinger unit, the dust falling into various can modifications below. The stovepipe samplers consisted of upright stovepipes with sampling cans on the bottom end. The stovepipes were perforated for the upper eight inches with round holes which were large and closely spaced at the top and small and widely spaced at the bottom. The effect was that of decreasing porosity from the top downward. Variations of the basic design consisted of two baffle designs inside the can.

After eliminating a number of unsuitable designs through study in a simply constructed dust-wind tunnel in the Soils green house at Davis, five designs were selected for field testing in peat land in the Delta. Collectors were setup in May in a line at the lee edge of a freshly ridged asparagus field with their tops at a level 45" above the tops of the asparagus ridges. Representative results are shown below. Collecting periods varied from 3 to 5 days.

Grams Dust Collected

Collector #	Description	Trial I	Trial II	Trial III
1	stovepipe	.344	.364	.440
2	slanted can	1.381	1.114	
3	stovepipe with flush baffle	.375		
4	vertical can with spiral baffle	2.014	1.639	2.011
5	stovepipe with extended baffle	.424		
6	stovepipe	.321	.344	.424

Comparison of collectors all relative to collector #1

(taken as 1.0)

Collector #	I	II	III	Ave.
1	1.0	1.0	1.0	1.0
2	4.02	3.08		3.55
3	1.09			1.09
4	5.85	4.54	4.57	4.99
5	1.23			1.23
6	.933	.950	.963	.95

Three important conclusions came from these (and other) trials:

1) The amounts of dust collected from all the models of collectors was large enough to be easily handled and weighed.

2) The can types were clearly more efficient than the stovepipe types. In addition, the can types trapped far fewer insects which caused difficulty in dust handling and weighing. The can types averaged only .33 insects per trial whereas the stovepipe types averaged 2.5 insects per trial. The one advantage of the stovepipe types over the can types is that they are omnidirectional.

3) The collectors were surprisingly precise. The ratio of efficiency of the stovepipe models did not vary more than 3% for the 3 trials. When the can types were compared with the stovepipe types, this constancy of relative efficiency was not maintained. This is explained by the fact that stovepipe types are omnidirectional while the can types are not. With only two trials to go by, it appeared the can types were equally as precise, the ratio of their efficiencies being 1.45 and 1.47 (taking #2 as 1.0).

As a result of the above, two more vertical can collectors with spiral internal baffles were made and calibrated in the field during the first part of June.

Calibration Data

	Grams Trial I	Grams Trial II	Grams Trial III	Relative Trial I	Relative Trial II	Relative Trial III	Ave.
#7	.436	1.521	.969	1.0	1.0	1.0	1.0
#8	.362	1.511	.814	.83	.99	.84	.88

Dust collectors #1, #6, #7, and #8 were used in the field to evaluate the effectiveness of snow fencing and inter-row planting. The pertinent data will appear in those sections.

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Inter-Row Planting Experiments

The term inter-row planting, as it is referred to in this report, specifically applies to the planting of barley or other grain between asparagus rows for the purpose of wind erosion control. The 10 acres of inter-row planting tried last year indicated its promising nature from both a dust control and a management standpoint. Many questions, however, were brought to light. The limited experience on only 10 acres (3 plots) and with one type of soil and management provided only partial answers for some of the questions and no answers at all for others. Among these questions were the following. Is barley the best plant to use? When should the barley be planted? Should it be drilled in or broadcast and in how wide a strip? Will barley volunteering be a serious problem? Is the barley detrimental to the asparagus yield? How can weed control be accomplished? Is it possible to work 7 and 7½ foot beds interplanted to barley? (The 1955 experiments were on 8 foot beds.) Can the barley be harvested? Is it successful in wind erosion control when the wind is parallel to the beds? Will there normally be enough moisture to get a stand of barley? How much does it cost? How can the asparagus harvesters work in it? Will thrips be a problem?

What was clearly needed was a vastly expanded experimental program of inter-row planting embracing the experiences of many growers with their varied soils and management practices. Supplementary to this would be needed well controlled small scale plots to study certain facets of the problem. To this end, two meetings for asparagus growers were called on September 13, 1955 and February 14, 1956 for the purpose of explaining the University's program. From these meetings and through personal contacts, twelve asparagus growers were lined up who were interested in cooperating in an experimental program of inter-row planting.

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Since three distinct kinds of experiments were done on inter-row planting this year, they will be taken up separately. Briefly described they are: (1) Small variety trials planted early in an attempt to protect green market asparagus against damage by wind erosion; (2) small variety trials planted later in the season to determine the feasibility and growing habits of certain tall growing millets and forage sorghums; (3) field sized inter-row planting experiments under a variety of different management and soil conditions.

Variety Trials for Market Asparagus Protection. It became apparent in 1955 that if interplanted barley could largely control the dust in an asparagus field, it might protect green market asparagus early in the season against wind damage due to flying dust and particles. On March 9, 1956 two plots were set out in peat soil asparagus fields on Lower Jones Tract to test the idea. The first plot consisted of 100 foot strips of grain drilled in by hand, 3 drilled rows per strip, 6" spacing. The strips were placed midway between the asparagus rows and were replicated several times, depending on the amount of seed available for each variety. The plot was arranged to form a solid block 200' x 160' with rows running east and west. The following varieties were tried: Merced rye; Ramona 50 wheat; Baart 46 wheat; Onas 53 wheat; California Mariout barley; Atlas 46 barley; Dicktoo winter barley; and Kearney winter barley. The second plot was similar to the first but was 150' x 150', had north-south rows and was planted to King rye.

On April 4, 1956 the plots were observed. California Mariout barley (14"-18" high) was the fastest grower while the two winter barleys (4"-6" high) and King rye (4"-8" high) were the slowest growers. Atlas 46 barley, Merced rye and the wheats were intermediate. There was considerable variability of height and vigor in all the varieties (apparently due to seed placement - deep or shallow, on shoulder of asparagus bed or down center of row) but the wheats seemed to be more susceptible to the variability than the barleys and ryes. The effectiveness of these plots for wind erosion control could not be checked. No blowing (dust) or crooks (asparagus culls) occurred on the fields due to their weediness and crust from rains.

Variety Trials of Tall Growing Grains. It was felt that strips of tall growing grains spaced 10 or 12 rows apart might have certain advantages over barley between every row (less volunteering in winter, easier for cutters to walk in the field). The following varieties were planted in duplicate in 300 foot strips between rows of peat land asparagus on Rindge Tract, 5/29/56: Starr Millet #9; Cattail Millet; DeKalb Forage; Haas Hegari, 1953; Hi Hegari, arasan treated; Ellis; Waxy Atlas; Kansas Collier; Atlas, arasan treated; Hegari. By June 4 most of the varieties were up 1/2" - 1" in good stand. By June 7 they were up 1" - 2" in good stand except for a few varieties which were sparse (could have been due to dryness or old seed). On June 15 at the closing of the asparagus season, these plots were all dug out in error by a tractor driver.

It is still felt that some of these varieties may have a place in some form of inter-row planting. It is planned that this experiment should be performed again in 1957.

Field Scale Inter-Row Planting. This paragraph should be prefaced with a description of the weather and other conditions during the spring of 1956. The month of April was unusually wet and cool. This was reflected to the asparagus grower in exceedingly weedy conditions and low production. The low production coupled the barley intact. Again on May 13, the beds were split open and re-ridged still leaving the barley intact.

Although no actual counts of culls were made, the cooperator claimed that during the fresh market season the interplanting cut his culls due to crooks down to almost nothing where these two fields normally produced more crooks than the other fields on the ranch.

The fact that the barley was planted early on these Terminous plots and maintained through the process of ridging for white asparagus gave rise to some unexpected difficulties. The process of ridging the asparagus beds left the barley strips themselves perched on flat, sharp-edged ridges several inches high. This made working in the fields more difficult for the cutters and gave considerable trouble to the jitney tractor drivers hauling asparagus out of the field. The problem was particularly acute when the barley became tall and thick because of the low clearance of the outboard asparagus sleds carried by the tractors.

Another effect of planting the barley early is that it becomes tinder dry before the end of the asparagus season. This creates a severe fire hazard because peat soils are easily ignited and peat fires are difficult to put out. This hazard is aggravated by the fact that dozens of laborers must go through the fields daily. One careless match or cigarette could cause the loss of an asparagus planting.

At one time during the white asparagus season, the Terminous cooperator indicated that he felt that asparagus production had fallen off in his interplanted fields (his records could neither prove nor disprove this) and that it possibly was due to a lowering of bed temperature due to shading effect of the barley. The rows had a north-south orientation. A few days later he split his beds open and re-ridged. Shortly after re-ridging, soil temperature measurements were made to test his hypothesis. Measurements were made by thermocouples and a Leeds and Northrup direct-reading potentiometer at depths of 6 inches and 1 foot in the center of the asparagus bed. All measurements were replicated by measuring at three spots along a 15' section of bed. The control was in the same field and near by the treated bed. The barley adjacent to it had been practically knocked out in field operations. Measurements on four different occasions and at different times of the day indicated there was no measurable difference in soil temperature between the interplanted bed and the clean bed. The one exception to this generalization was the measurement at the 6" depth one day at 8 p.m. (PDT). The average temperature at the 6" depth for the interplanted bed was 3.2° F. higher than for the non-interplanted (clean) bed. Although these measurements did not disprove the cooperator's hypothesis (because of the breaking down and re-ridging of beds prior to temperature measurements), the higher bed temperatures at 6" late in the afternoon seems to indicate that the heat trapping effect of the barley was greater than any shading effect that might have been produced.

Although there was no adequate control field to compare with the interplanted 80 acres, it was quite apparent that the barley was very effective in combating wind erosion during the white season. The two interplanted fields were considered by the cooperator to be the dustiest asparagus fields on the entire ranch. Yet, on several occasions during wind storms, other fields were seen to produce considerable quantities of dust while little or no dust could be seen coming from these interplanted fields. On one occasion the cooperator observed the fields during a windstorm which, he said, would have caused large quantities of dust if not actually blown the ridges flat. With the interplanting, the ridges were virtually untouched by erosion and little dust was seen originating from the field. On one occasion, one of the 40-acre interplanted fields was being re-ridged during a brisk wind. Although non-interplanted asparagus fields in the vicinity were blowing mildly to moderately, the very freshly re-ridged interplanted asparagus field was not blowing at all. Normally, freshly re-ridged asparagus is particularly subject to wind erosion and dustiness.

The three barley varieties tried on these two Terminous fields showed differences in their suitability for inter-row planting. The Mariouts (Golden and California) proved to be the fastest growers early in the season and on April 24, 1956 were found to be 4" taller than the Arivat and with stiffer more upright leaves. At the end of the season, however, there was no essential difference in their heights and the Arivat was more upright and dense. The Golden Mariout appeared to be quite weak strawed and did not make a good, continuous, upright windbreak. On the basis of this limited experience, it would appear that California Mariout is the best variety to use in early interplanting for the purpose of protecting green market asparagus. Whether California Mariout or Atlas would be best for late planting (April 1-30) to protect white asparagus was not determined.

4) In addition to the 80 acres of inter-row planting on Terminous described under 3) above, four other fields totaling 75 acres of asparagus were also interplanted to barley. They were all oriented east-west (the direction of a majority of the damaging winds) and were planted with only a single row between the asparagus beds. The planting was done on April 28 and 29, after ridging the beds for white asparagus. On May 22 the cooperator observed these fields during a wind and concluded that the barley helped to some extent. Three days later the barley was measured and found to be 9"-10" high and in heavy stand. On this date (May 25) the interplanted barley seemed to have a significant moderating effect on the wind.

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At 4:15 P.M. on June 9, 1956 dust collectors #7 and #8 were set up at the east ends of one of the interplanted fields and an adjacent control field respectively. The collectors were over the center of a ridge with their tops 34" above the top of the ridge. A strong wind from due west was blowing and a dust storm was beginning. One could easily see the full length of the interplanted field (a long, narrow field of about 30 acres) with only a little dust coming off here and there. On the other hand, the adjacent control (non-interplanted asparagus) field was so dusty that it was difficult to see across its short dimension. It was estimated at the time that 5 times as much dust was coming from the non-interplanted field as the interplanted one. The next morning the dust was taken from the collectors and subsequently weighed. The following are the results:

Collector	Field	Grams Collected	Collector Eff.	Relative Dust
#7	interplanted	2.655	1.00	1.0
#8	control	14.255	0.88	6.1

It can be seen from this data that for this particular storm the dust density over the non-interplanted field was about 6 times that over the interplanted field even though the wind was blowing straight down the rows. Whether this high ratio would have occurred if the wind had been of higher velocity is open to question.

5) A factor in addition to the lateness of the beginning of the white asparagus season hampered inter-row planting experimentation in 1956. This was the early cessation of asparagus harvesting. By order of the State Director of Agriculture, all harvesting of white asparagus stopped on June 15. Normally the season goes to about the end of June. Some of the late planted inter-row barley would have been tall enough to be at least partially effective against the storms during the last half of June if the asparagus season had been of normal duration.

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6) Two other points, not adequately covered in the attached booklet should be brought out. The first concerns the volunteering problem. If the interplanted grain goes to mature seed before being knocked down, there is the possibility of a serious weed problem in the late fall and early winter due to the volunteering of the grain. From the experience of the 1956-1957 winter season, it appears that the problem of volunteering varies considerably with local conditions. On Mandeville, 3 extra diskings were required, starting after the first fall rains, to adequately control the volunteering barley. On Terminous, 2 normal (would have been done despite the barley) diskings during early winter completely controlled the barley. On Staten, no volunteering had taken place by the end of December 1956 due to lack of moisture. The reasons for the variation in volunteering have not been determined. The sudangrass interplanting on Bacon did not volunteer at all and search for seed indicated that it probably rotted.

A facet of dust control in asparagus which has not been studied deals with that period of time between the end of the harvest season, when the ridged beds are knocked down, and the time that asparagus fern has grown sufficiently to give some ground cover. The experiences of two cooperators in 1956 indicated that inter-row planting might offer a solution. Both cooperators were able to knock down their asparagus beds at the end of the season, leaving their interplanted grain intact. Later on, after the fern was up, they were able to successfully disk the standing grain into the soil. In one case it was a thick stand of sudangrass 6' tall. Although these observations indicate the possible feasibility of leaving inter-row planting standing until after the fern is up, it will require a grain or other plant which will normally remain green long enough so as not to constitute a fire hazard.

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Dust Control on Roads

<u>Orzan 503-S</u> Orzan 503-S is an emulsion of #3 road oil in water and stabilized by large quantities of Orzan (25% of total). Orzan is a lignin-derivative by-product of paper making, and has been used for road stabilization of logging roads in the Pacific northwest. The emulsion form is said to have superior properties. Plots were established on Mandeville Island on a much used mineral soil field road and a moderately used peat soil field road. The rate of Orzan 503-S application on the mineral road was as recommended by the manufacturer while that on the peat road was double that normally used.

	Mineral road plot	Peat road plot
date of application	10/17/56	10/18/56
plot size	15' x 120'	10' x 90'
gals. Orzan 503-S	100	100
gals. water	200	200
dilution ratio	1 to 2	1 to 2
gals. Orzan/sq. yd.	0.50	1.0
wetting agent	none	1 lb. Oronite Nl-W

Prior to a rain on October 30, the mineral road treatment took very poor but the one on peat soil appeared to have some promise. Two weeks after the rain the treated and untreated sections of the mineral road had a hard compaction pavement on them, making dust observation impossible. On November 14, 1956 a very windy day, dust collectors were set out at the leeward corners of the treated and untreated sections of the peat road. There being no natural traffic on the road at that time of year, 20 passes were made by a pickup truck at 20 mph. Noticeably greater dust was collected at the control plot than at the treated plot. The quantities collected were not adequate for transfering and weighing. Observation of vehicles passing over the peat road showed a considerable diminution in dustiness while the vehicle was passing through the treated plot. This factor of dimunition was estimated at about 3 or 4 when a heavy caterpillar tractor passed the plots. The cost for materials delivered in Stockton would run about $360 per mile, 9 ft. wide. Observations on the two plots will be continued in 1957.

Calcium Chloride. The treatment of a peat soil with calcium chloride at Davis in laboratory sized tests was carried out in May 1956. Dry peat soil was put into shallow wooden trays, struck off flush then sprinkled with $CaCl_2$. After being allowed to stand 5 days, they were set flush in the floor of the wind tunnel constructed in the Soils greenhouse.

Dust collected from wind
tunnel at 20 MPH wind

Treatment	Dust collected
Check	0.98
0.5 Ton/acre	0.47
1.0 Ton/acre	0.18
2.0 Ton/acre	0.02
2.0 Ton/acre, scratched	0.13

It is apparent that the deliquescent nature of calcium chloride can cut down on the dustiness of peat soils. Whether such treatment can stand much traffic or is too expensive has yet to be studied.

Snow Fencing for Dust Control

Snow fencing is used extensively in conjunction with willow windbreaks in the peat areas of New York state. It was thought that they might work to stop dust in asparagus fields. Four strips of snow fencing 4' high and 200' long with a spacing of 70' (10 asparagus rows) were installed in ridged white asparagus on Rindge Tract on May 31, 1956. The fencing was put on top of the asparagus beds and supported by either 6' redwood grape stakes or standard steel fence posts. These were each spaced at 10 foot and at 15 foot intervals. No guys were used at the ends. The fencing ran generally southwest-northeast.

The plot was observed during two dust storms. In both instances it was very difficult to assess its value. With much dust in the air it was difficult to see if less dust was coming off the relatively small plot. The small size hampered evaluation in another way. The winds hit it at about a 30° to 45° angle and because of the shortness of the plot (200 feet) there was considerable end effect where the wind swirled around the ends of the fencing. In general, it appeared to have little or no effectiveness.

Dust collectors were set up at the plot on June 7, 1956. One collector was set in front of the plot (to windward) while the other was set near the leeward edge of the plot, midway between fences #3 and #4. Results:

Collector	Treatment	Grams Dust	Collector Eff.	Relative Dust
#6	fence	1.791	.95	1.0
#1	control	2.870	1.0	1.52

From the visual observations and dust collection data, and the high material and labor costs, it would appear that snow fencing is not a practical solution to the dust problem in asparagus. Nevertheless, the fence was left in place and will be studied for wind velocity profile in the spring of 1957.

Bamboo Windbreak

A trial planting of Phyllostachys bambusoides (giant timber bamboo) was planted along a minor drainage ditch (so-called "four foot ditch") at the edge of an asparagus field. P. bambusoides was chosen because of its tall stature (up to 70' in large clumps), hardiness against cold weather, and ready availability. It lacks the heavy, extensive root system of most windbreak trees which stop up drainage ditches and sap moisture and nutrients from cropped land. It also seemed possible to control its spreading habit by cutting the new rhizomes with a subsoiler at an appropriate time of the year.

Twenty-eight plants from the USDA Plant Introduction Garden at Chico, California, were set out on April 18 and 20, 1956. Ten plants (some were rhizome stock) from a local planting on Bishop Tract, believed to be P. bambusoides, were set out on April 18 and 27, 1956. In mid-July, during a hot spell, the watering of the plants was neglected and all growing plants died back or were severely wilted. Later, after proper care had been restored, all of the injured plants revived and again began growing. The final survivals were: Chico plants, 21 (75%); Bishop Tract plants, 7 (70%). By the end of the fall all survivors were growing well and looked healthy. By the first of November they were still growing and sending up new culms. It was feared they might not harden off sufficiently to withstand the early winter frosts. On November 27, after several frosty nights, the bamboo was examined and found to have suffered extensive frost damage. All new growth had been killed as had the largest part of most of the plants. A few plants suffered only a slight leaf kill. Although probably none of the plants were killed, this damage will surely set the plants back.

New Crop Possibilities

These are joint projects with the Agricultural Extension Service (and in the case of blueberries, also with the Pomology Department) with the local Farm Advisors Office taking the main responsibility for the field work. Their purpose is to try to find new crops for the Delta, which by their nature would minimize wind erosion and perhaps combat subsidence by allowing a raised water table. It will be necessary for them to economically compete with crops presently grown in the Delta.

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Christmas tree variety trial. Of the three species which in 1955 made poor stand and growth (white, red and Douglas fir), white fir was replanted in 1956. This time, with better stock and more care, the survival was nearly 100 per cent and considerable growth was made during the year. A new species, Scotts pine, was also planted in 1956. The species other than fir (Monterey pine, Allepo pine, Arizona cypress, and Sequoia gigantia) made excellent growth during the year. Allepo pine, Arizona cypress, and redwood stood 4' to 5' high by the end of the season. Several of the Monterey pines got to 7' and had fair shape and good foliage. Only limited pruning was done on a few trees. One Monterey pine was cut and made a very satisfactory Christmas tree. An 18" stump with one whorl of branches was left in the field to determine if stump culture was feasible with this species. The Monterey pines grew to a height in two years which normally requires four to six years on Christmas tree plantations in Santa Cruz county.

Blueberries. The blueberry variety trials are fully reported under Experiment Station Project No. 1386 (Pomology Department, Davis). On April 6, 1956, 450 blueberry plants of various ages and representing 15 varieties were planted in peat soil in the Delta. The plantings were on three different tracts or islands. Survival of some varieties was very poor but those which did survive put on excellent growth. By the end of the year there was an over-all survival of 64 per cent. Most of those which did not survive were rooted cuttings. It was learned that standard New Jersey commercial practice was to use 2 and 3 year-old plants, never rooted cuttings. Since blueberries can stand a high water table (12"-18") and are even benefitted by it, it appears that blueberries would be a particularly beneficial crop from a peat soil subsidence standpoint.

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Davis, Soils and P. N.

January 14, 1957

Irrigated Pasture. During the week ending March 9, 1956, approximately 40 more acres of grass-legume pasture were seeded. In the latter part of June and early July, 1956, this new pasture was stocked with 135 head of small steers. On July 19, 1956 the 54 head carried over the winter from the previous year (with supplemental feeding of screenings from grain cleaning operations) were confined to about 5 acres of pasture and put on a supplemental feeding program. The extra feed consisted mostly of screenings. On December 27, 1956 these 54 head of cattle were sold. Forty-four head averaged 1,101 lbs. and graded choice while ten head averaged 1,000 lbs. and graded below choice. These cattle averaged 465 lbs. in weight when they were put on the peat land pasture in July, 1955. Their gain amounted to over 1,000 lbs. per acre per year. The contribution of the supplemental feeding to this gain has not yet been calculated. Such calculation will give an estimate of beef production on irrigated pasture.

To date the copper feeding program of the cattle has not been well controlled or recorded. Supplemental copper is, however, apparently essential for cattle thriftiness. The cooperator throws a handful or so of blue vitriol in the drinking troughs whenever the cattle appear to be getting "too loose".

It appeared that more basic work should be done on the subject of Cu-Mo relationships. Since recent work had shown that SO_4-S is also involved in the Mo problem, it was decided that SO_4 should be brought into the study as well. To this end, C. M. Johnson, Soils and Plant Nutrition, Berkeley, became a cooperator in this phase of the project. It was decided that monthly samples of forage and periodic samples of soil should be analyzed for Cu, Mo, and SO_4-S in order to get an idea of the magnitudes of these elements and how these vary with the season.

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The following tables show the results of these analyses (soil analyses not yet completed).

Sampled September 25, 1956

Sample	p.p.m. on dry weight basis		
	Mo	Cu	SO_4-S
Clover, old pasture	18	9	2260
Harding grass, old pasture	17	14	2850
Clover, new pasture	38	9	830

Sampled October 30, 1956

Sample	p.p.m. on dry weight basis		
	Mo	Cu	SO_4-S
Clover, old pasture	15	14.5	2240
Harding grass, old pasture	16	20.0	1710
Clover, N. end new pasture	31	7.9	425
Clover, S. end new pasture	25	7.9	570

These figures indicate a high variability from field to field in the amounts of Mo, Cu, and SO_4 found in forage. This points up even more the importance of a basic understanding of the molybdenum problem if we are to be able to advise on the proper treatment and management of cattle on peat soils.