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UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

PROJECT NO. 1686

REPORTED BY A. B. Carlton

Davis, Soils and P. N.
Campus and Division or Department

DATE January 16, 1961

Annual Summary Statement of Progress for year ending Dec. 31, 1960
This Summary is in addition to, not in place of, more complete reports of progress prepared periodically and at least once a year with a deadline of Feb. 1.

Title: Peat Land Conservation and Peat Dust Abatement

Personnel: Alan B. Carlton and cooperating research and extension staff

Principal results of year: Dust storms were monitored and compared with distribution of storms in the five previous years. The year's distribution of dust storms by months was again very close to the long term average. The detailed distribution within the critical months of May and June was somewhat different, however, there being a larger percentage of storms prior to May 16 than usual. Sufficient data had been collected in six years to allow examination of dust storms caused by northerly winds. They were far more scattered throughout the year than westerly dust storms, there being a broad peak of such storms in March, April and May and a secondary period in October and November.

A technique of sampling dust clouds for peat soil loss by wind erosion was studied. No suitable dust storm occurred after the equipment was assembled and techniques worked out. A peat ash storm from a burning peat field was studied by the method, however, and rate of surface loss was estimated at 1/4" per 100 hrs. in a 9.6 mph wind.

Five years of experimentation with inter-row planting of barley in white asparagus for wind erosion and dust control showed too high a percentage of failures or only partial success. Seeding of the grain into ridged white asparagus after the conversion process too frequently caused the planting to be too late to be effective. This year large blocks were planted with new techniques earlier in the season into green asparagus of various bed widths. It was found that the grain could be successfully interplanted before conversion to white asparagus in 7', 7½' and 8' beds but not 6' beds. Evaluation by a number of methods showed a high degree of effectiveness in preventing wind erosion and dust when the grain was planted early and maintained in good stand. Elimination of up to 95% of the dust during a storm by inter-row planting was recorded.

Clear polyethylene sheeting was used to raise the soil temperature of asparagus beds in the winter. Rises of over 8° F. at 7" depth were obtained in six days. The asparagus began producing earlier in plastic heated beds and maintained a higher rate of production for a period of time.

Publications: None.

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Dust Storms

As in past years, observations of peat dust storms were made throughout the calendar year. Such observations and subjective classification of the storms during the past five years have shown a clearly defined pattern of storm distribution throughout the year. (See section on Dust Storms in annual reports 1955-1959 inclusive.) Observations were continued during 1960 to determine again how closely individual years conform to long-term averages.

The first recorded storm occurred on March 16, 1960, while the last one was on October 15, 1960. Fifty peat dust storms were recorded, thirty-eight of which were caused by more or less westerly winds and hit Stockton and/or Lodi. Ten were caused by northerly winds and for the most part by-passed Stockton and Lodi. One dust storm (April 26, 1960) was caused by strong S to SE winds and missed major metropolitan areas.

With fifty recorded peat dust storms, 1960 ranks record only to 1959 in the six years covered by the project. However, as explained earlier in this report (pp. 35 and 36), numbers and intensities of recorded dust storms are not necessarily comparable one year with another. The general consensus seems to be that 1960 was neither a particularly "bad" year for peat dust nor was it a particularly "light" year. The cost and labor involved, because of the tremendous variability of these storms in time and space, to provide more objective measurement of dust storm intensity does not seem to be warranted for the accomplishment of the objectives of this project.

The following data for peat dust storms for 1960 are arranged in the same pattern as reports from previous years. The statements on pp. 35 and 36 of the 1956 report relative to definitions and changing standards from one year to another are fully applicable to this report.

Westerly dust storms hitting Stockton and/or Lodi:

Number of storms by month

	1960
January	0
February	0
March	1
April	8
May	11
June	11
July	2
August	3
September	2
October	0
November	0
December	0
Total	38

Number of storms by half-months for May and June

		1960
May	1-15	7
May	16-31	4
June	1-15	6
June	16-30	5

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Tally of storms by severity:

	Number of storms by severity 1960
Very severe	0
Severe	5
Moderate	5
Mild	17
Very mild	11

Severity by months, 1960:

Number of storms

	Mar.	Apr.	May	June	July	Aug.	Sept.
Severe			2	2		1	
Moderate		1	2	2			
Mild	1	4	3	5	1	2	1
Very mild		3	4	2	1		1

Distribution statistics for westerly storms: Dust storm distribution of previous years has been compared with the average for all years then available. Frequency of storms for each of the past six years is compared with the six-year average in the table below.

Per cent of storms (all categories) in each month

	1955	1956	1957	1958	1959	1960	6-yr. Ave.
March	0	6	0	0	0	3	2
April	11	7	9	0	7	21	10
May	22	29	24	27	38	29	29
June	41	29	30	55	24	29	32
July	11	10	12	14	16	5	11
August	0	19	18	4	11	8	11
September	11	0	7	0	4	5	4
October	4	0	0	0	1	0	1

It will be seen from the table above that the 1960 distribution of westerly dust storms conformed very closely to the six-year average, the main points of difference being that April had somewhat more and July somewhat fewer than the average. The high frequency of storms in May and June held true as it has for each of the years in the six-year period.

One difference in storm distribution from most other years is more apparent than real. In four out of the five previous years, a large increase in dust storms occurred in May after the 15th. In 1960 there were more storms in the first half of May than in the second half. Actually, the usual rise of storm activity near mid-May did occur although it is not seen in the tabulations. Four of the seven May 1-15 storms occurred May 12-15, inclusive. Whereas in previous years about 67% of the years' bad storms (moderate, severe, and very severe) occurred in the period of May 16-June 30, in 1960, 60% of them occurred during this period. If "mid-May" were to include May 14, then the figure would be 80% for 1960.

The striking fact that these figures bear out is not the small difference from year to year but the very close similarity which each year bears to the six-year average. There can be little doubt that the "hard core" of the dust problem lies in the months of May or June when more than 50% of dust storms from westerly winds occur and more than two-thirds of the bad storms from these winds. Mid-May generally seems to be the beginning of this concentration of storms.

Northerly dust storms generally by-passing Stockton and Lodi:

There were 11 storms in this category in 1960.

Storm category	Dates, 1960
Severe	6/20, 10/9
Moderate	3/16, 5/18
Mild	4/16, 6/2, 8/16, 10/8, 10/15
Very mild	9/21, 5/4

Distribution statistics for northerly storms: For the first time in these reports there has been enough data collected on northerly storms to make distribution statistics meaningful. In the table below, totals of all recorded storms for the years 1955-1960 inclusive are listed.

Number of northerly storms for 6 years (1955-1960) by severity:

	V. Mild	Mild	Moderate	Severe	Total	Severe + Moderate
January	0	0	0	0	0	0
February	0	0	1	0	1	1
March	1	1	2	1	5	3
April	2	2	1	2	7	3
May	1	1	3	1	6	4
June	0	1	0	1	2	1
July	0	0	0	0	0	0
August	0	1	0	0	1	0
September	1	0	0	0	1	0
October	0	3	1	0	4	1
November	1	1	1	1	4	2
December	0	0	0	2	2	2

It may be seen from the above table that the northern dust storms, unlike the western dust storms, do not have a high peak of occurrence but tend to occur more generally throughout the year. A broad period of highest occurrence does occur during the months of March, April and May with a secondary period in October and November. The bad storms (moderate and severe) seem to follow the same distribution as for all storms combined. January and July have been the only months free of northerly dust storms. Any means to attack dust storms from northerly winds should be operative in March, April and May and perhaps in October and November as well.

Southerly or southeasterly dust storms missing San Joaquin County cities:

Storm category	1960
Moderate	4/26

This is the second year of this project that a S-SE wind has caused a dust storm (see p. 65 for 1957). These rare storms are caused by high velocity winds preceding a rain front and last only a few minutes to around two hours before the rain settles all dust.

Dust Sampling Activities

Preparations were made for dust sampling which it was hoped would give a direct, although rough, estimate of dust lost from the delta area or from a specific source. The idea was to sample dust in a dust cloud downwind from its source. A high volume Staplex filter sampler was to be used. The cross sectional area of the dust cloud at the point of measurement, the wind velocity, and the length of time the dust blew would be estimated. Assuming uniform dust density in the cloud and that the sampler obtained a reasonably true aliquot, the total weight of dust passing the point of measurement could be calculated. Despite the several pitfalls and difficulty of getting satisfactory estimates of all necessary factors, this is the only direct method of dust loss determination so far considered which appears simple enough and feasible.

The first problem to be solved was that of sampling. Pleated high volume filters for the Staplex samplers were found to be very hygroscopic, taking on up to 300 mgs. of water at 35% humidity. After desiccation, the rate of weight increase due to absorption of water was far too high, 7 mg. per minute, to make accurate weighing possible. To overcome this problem, filters were dried in an atmosphere in equilibrium with a $CaCl_2.6\ H_2O$ - water system or a suitable H_2SO_4 - water system. A drying atmosphere of 35% R.H. was used as standard and came close to normal laboratory humidity. Change in weight while weighing was therefore minimized. The sulfuric acid system has the advantage of maintaining constant humidity over a fairly wide range of temperatures, whereas the saturated calcium chloride system has the advantage that its humidity does not change with the absorption of water as long as there is solid phase present.

A portable power plant was installed in a pickup to furnish power to the Staplex sampler which was carried in the field at all times. Unfortunately, no suitable peat dust storms or clouds were encountered after the equipment had been assembled and tested. The setup was tried however on an occasion when a burning peat field was encountered. The wind was 9.6 mph and, although insufficient to cause peat dust to blow, a large and dense cloud of light colored peat ash was being caused by wind erosion on the field. This cloud was sampled at 6' height about 100 feet downwind from the field. The height of the cloud was estimated at 50 feet at the point of sampling and appeared to be fairly uniform in density with height. A sample of 300 mg. was collected in 10 minutes at 50 CFM. Calculations based on the assumptions enumerated above indicate a loss from the field of 6.4 grams of ash per square foot per hour (610 lbs. per acre per hour). Using 1.0 as the bulk density for the ash in place, this amounts to 0.007 cm of thickness lost per hour or approximately 1/4" per 100 hours. Visually, this cloud was quite dense compared to most peat dust clouds. It is most likely that on the whole, peat dust loss from the islands occurs at a rate below that observed on this burning field. It is of interest to note here that in 1959 in the period April-September inclusive, 202 hours occurred with wind velocities over 15 mph which is roughly the critical velocity for a peat dust storm.

No significance can be attached to this single experiment except to indicate that this approach for direct measurement appears feasible and yields results which appear reasonable. Many more measurements of this kind must be made before reliable estimates of dust loss can be made.

Inter-Row Planting Experiments

Inter-row experimentation in 1960 differed somewhat from previous years in that it became more of a "community project". It became both the object of widespread inspection and appraisal by the public and the testing ground for a new technique which seemed to be indicated by certain failures and problems of past years. At the suggestion of the San Joaquin County District Attorney, a committee of citizens appointed by the Board of Supervisors (San Joaquin County Peat Dust Evaluation Committee) sponsored an inter-row planting project on large blocks of land. The District Attorney desired this for the purpose of evaluating inter-row planting for dust control from the air. A growers' organization, the Delta Growers and Landowners Association, cooperated by providing the necessary cooperating growers. City (Stockton), county, and growers provided funds up to $10,000 to compensate cooperating growers for their costs. An additional $500 was granted to the University to assist in the planting and evaluation.

The change in technique mentioned consisted of planting the inter-row grain into a slightly furrowed out center between asparagus rows in green asparagus early in April. This technique seemed dictated by experience over several years which showed a high rate of unsuccessful, or only partially successful, inter-row planting when planting of the grain was done after the conversion of the asparagus to white cannery production. Inter-row planting under this method frequently did not get planted until late April or May. On several occasions, there was insufficient moisture in the ground at this late date for the barley to grow properly. Even when moisture was adequate and barley growth was normal, the grain did not reach a bare minimum height for dust control until late May or early June when one-third to one-half of the major dusty period was over. In addition, the long days affected the photoperiod growth response to the extent that the barley never attained its maximum mature height.

The only way to guarantee a higher percentage of successful inter-row planting was to get the grain planted earlier which meant planting into green asparagus before ridging for white took place. However, experience had shown that ridging to white in the presence of inter-row barley always left an undesirable steep-sided ridge between asparagus rows, and that such ridging was not even possible without the destruction of the barley, at least with two or three barley rows per strip, on beds of 7½' width or less. A possible solution to the problem seemed to be planting the barley into a partly furrowed out center between asparagus rows and using only a single row per strip. (See par. 7), p. 71; par. 11), p. 72; par. 8), p. 104; pars. 5) and 6), p. 136 of these reports.) Even so, there was some question whether such technique would work on 7' beds (par. 8), p. 136). What was required was to furrow out the center deeply enough so the grain planted in this furrow would not be perched up on a ridge after conversion to white asparagus took place. It would also be necessary that the dirt moved from between the asparagus rows be moved to the shoulder of the asparagus beds where it would be available for ridge building later on, yet not be piled on the growing green spears.

In addition to the large block field scale inter-row planting program, variety trials for finding suitable inter-row grains were again planted. In contrast to previous years' work done in separate test plots, the variety plantings were made as inter-row plantings in established asparagus fields. Fertilizer and gibberellin effects were studied on these plantings as well.

Since the volunteer problem associated with inter-row planting occurs during the winter and following spring, few inter-row planting experiments can be considered complete within the calendar year. The carry-over volunteer problem from the 1959 experimentation was observed and is reported here.

Volunteer from 1959 inter-row. Two of the three 1959 inter-row plantings produced barley volunteering in the asparagus fields. These were the Rindge and the Terminous plantings. This was the first year that inter-row volunteer posed a potential problem in the Terminous fields and was also the first year in which winter flooding was not practiced on these fields. Some of the Rindge fields were flooded during the winter and none of the flooded fields had surviving volunteer barley although stands in the unflooded fields were fairly thick. Adequate winter flooding appears to eliminate volunteering barley as a problem.

The 1959 report (par. 10), p. 137) indicated that by the end of 1959 the volunteer barley in the Terminous planting had been all but eliminated by normal field operations. By mid-March, 1960, however that which remained—and perhaps some which germinated over winter—was giving some trouble (although never serious) in the harvesting of asparagus. Some of the volunteer had come up in the asparagus rows and made it difficult for harvest labor to see and cut the green asparagus spears.

In contrast to the Terminous planting where a considerable amount of the volunteer barley was in the asparagus rows, after the first pre-season disking on Rindge virtually all the barley was in a 3' band between asparagus rows and most was within a 2' band. All large and tall clumps were in a 2' band. At this stage (Feb. 4, 1960), the barley volunteer was of two types. There were large clumps mostly 10"-20" high and containing 40-100 stalks per clump, and small clumps 6"-10" high containing 10-20 stalks. Counts on typical rows showed about 30 small clumps and 23 large clumps per 100' of row. It was feared this much volunteer might constitute a serious problem. However, on February 24, 1960, these rows were disked (a normal disking--not for the purpose of barley volunteer control) without difficulty and the barley volunteer was nearly destroyed. The little volunteer left produced no problem during the season.

The experience of this and previous years may be summarized as follows. Adequate flooding kills or so nearly kills volunteer barley as to prevent it from being a problem. The low rates of seeding currently used (10 lbs-15 lbs barley to the acre) seem to prevent serious problems such as were experienced earlier with much heavier rates of barley seeding. Disking to knock down inter-row barley at the end of the season and subsequent weed control cultivations and diskings should attempt to maintain the barley stubble between the asparagus rows to prevent barley seed from being moved into the rows. Timely extra cultivations may be needed in special cases to prevent green growing barley in asparagus rows during the market season.

Variety-fertilizer-gibberellin plots. In addition to the most promising inter-row grains tested over the past few years (Onas 53 wheat, Swedish oats, California Mariout barley, Rojo barley) several previously untried small grains were planted in observation plots to assess their potential usefulness for inter-row planting purposes. These were Pacific Bluestem and Big Club 43 wheats; Traill, Montcalm, and Kindred barleys; Svalof Fourex rye (a tetraploid); and Curt oat. The wheats had been picked from an extension service wheat variety plot in peat the previous year as being potentially useful for inter-row planting. They showed resistance to lodging and considerable leafiness.

The grains were all planted into ridged white asparagus at the time the remainder of the field was being field scale inter-row planted to barley (April 27, 28). On May 23 when all grains were still short, young and tender, they were largely destroyed by a careless job of re-ridging. Some of the damage was caused by the complete burying of the grain. An attempt to recover the plot by uncovering the grain rows by hand was only partially successful. As a result, no useful evaluation from the plots was obtained.

Experience in the delta organic soils indicates that phosphate fertilization speeds up early growth of small winter grains. To test this effect on inter-row planting, super-phosphate and ground rock phosphate trials were both incorporated into the variety plots. As with the variety plots, no useful information was obtained from these trials because of the damage done to the plots.

The effect of gibberellin spray on the growing grain (barley) was studied at four levels of gibberellin viz. 1 ppm; 10 ppm; 100 ppm; 1000 ppm. The gibberellin treatment was done on May 28, one month after planting. The three lower concentrations were used on field inter-planted good barley undamaged by re-ridging. The three higher concentrations were used on poor, partially damaged barley of the variety plots. Later, when observed for growth response, only the 100 ppm treatment in good barley showed any easily visible response--about 4" taller than control. This experiment should be repeated again with earlier planted grain sprayed at different stages of growth.

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Large block field scale inter-row planting. In addition to the five growers who participated in the public sponsored inter-row experiment, one grower privately interplanted a large acreage on 7', 7½' and 8' beds. In the "official" experiment, 1,350 acres were offered for interplanting in solid blocks of 100 acres or more. Some of this acreage was left unplanted to act as controls while some of it was taken out of asparagus production before the start of the season, leaving 1,119 acres actually inter-row planted. All acreage was planted in single drilled rows and into furrowed out centers when planting was done in green asparagus prior to ridging for white. It was agreed that everyone would try to begin planting by April 1 and complete the planting by mid-April.

Table of plantings:

Island	Acres	Row Spacing	Grain	Planted into green or white	Date Planted
Staten	156	7'	Rojo	white	4/19-4/21
Terminous	96	8'	Onas wheat-Golden Mariout mix	green	4/5-4/6
Rindge	375	8'	Mariout-Arivat mix	white	4/22-4/30
King	104	8'	Arivat	green	3/24-3/25
McDonald	388	7'	Rojo, Calif. Mariout	both green and white	3/31-4/23
Lower Jones ca	80	7'	Calif. Mariout-Bannock oat mix	green	4/13-4/15
Bacon	331	7'	Barley	green	4/10-4/11
		7½'	Barley	green	4/1-4/4
		8'	Barley	green	3/26-4/7

As in most previous seasons, peculiarities of the season, either climate-wise or from an asparagus marketing standpoint, affected to some extent the inter-row planting program. Early in April, conversion to white asparagus seemed imminent to some of the growers. Therefore, two of the growers decided to wait until after conversion to white before interplanting to eliminate the furrowing out required in green asparagus interplanting and to eliminate the chance of loss of very young interplanting in the conversion process. Conversion to white asparagus was not as imminent as anticipated, the result being that the barley interplanting was not accomplished until after mid-April for these growers. Early conversion to white asparagus caused the loss of considerable interplanting on two islands. In one case, conversion on 7' beds took place a few days after the barley planting. The germinating barley was not quite up and much of it was destroyed in the conversion process by tractor wheels and disk blades. In the second case, also on 7' beds, the barley was up only 1" or 2" and was deeply buried under several inches of dry soil from improperly set disks. Some of the latter inter-row planting was saved by an extra operation scraping most of the excess soil off the barley rows. Planting was delayed to some extent on two wet fields by a buildup of slime on the asparagus which, it was feared, would require deep splitting of the 7' beds and might destroy the young barley interplanting.

Due to the reasons given above, only three of the six growers got all their interplanting done within the target period. One grower got most of his planting done within the period while two growers did not do their planting until the last half of April. With continuing experience on the part of the growers with the new technique and better familiarity with the problems it poses, more planting in March and early April should be possible.

Another factor of the weather contributed to lowered effectiveness of inter-row planting in 1960. For some reason barley in the delta did not grow well. Most commercial plantings suffered, as did the inter-row planted barley. Arivat barley, which normally would have reached 30"-33" height under the conditions, grew to a maximum of only 24". This lowered height, poorer stand, and sparser vegetative growth impaired its ability to control wind erosion.

Despite the difficulties, the experiment was highly successful from several standpoints. It allowed adequate evaluation not only from the air by the District Attorney for its dust control effectiveness, but also from the management standpoint of a number of untried methods. It showed that barley could be interplanted into green asparagus and maintained throughout the season, even on beds as narrow as 7'. Of particular importance was that it clearly demonstrated to the public that successful inter-row planting very materially cut down the dust leaving white asparagus fields on windy days.

The following numbered paragraphs list the more pertinent management facts and observations obtained from the 1960 inter-row planting program.

1) Experience indicates that the planting period for inter-row should be pushed earlier to the period March 15-April 7. Weather, soil moisture conditions, and weeds permitting, the earlier planting will not only be up high enough to control dust storms earlier, it will also be taller and stronger to stand the rigors of splitting and conversion to white asparagus. Weather, soil, and weed conditions will not always allow inter-row planting to take place and this longer, earlier period should provide a better chance that inter-row can be successfully planted.

2) Three different types of equipment were used for furrowing out the centers prior to planting. One was a drag type (front section of a splitting disk with outer blades removed). It worked satisfactorily in an 8' planting but would not work properly on 7' beds where fairly deep furrows were required. It would not track true nor would it cut deeply enough. Several types of tool bar mounted ridging disks were successfully used. The 3-bladed, graduated type seemed to be more suitable than the 4-bladed type. Flat bottomed furrowing shovels were constructed by two of the growers. They were built by welding vertical steel plates to the back edges of Vee-knife weeder blades and showed promise of being more suitable for the purpose than disks. Custom designed or adjustable wings at the rear edge of the shovels or crowders can drop the spoils from the furrow anywhere on the ridge shoulder that is desired.

3) Gauge wheels were used on the tool bars carrying furrowing equipment and planters in a number of cases. Their use considerably increased the uniformity and general over-all quality of the work done. They would be especially useful on some wheel tractors which have a tendency to bounce on the tires causing the depth of furrowing out and planting to vary.

4) Whenever disks are used for furrowing out, some method must be employed to break down the sharp peaked ridge left by the center of the disks as this is the line down which the planter will plant the barley row. A heavy chain dragged in a "U" behind the disk knocks this down to some extent but is not entirely satisfactory. In one case, a round drag made from a disk blade with a cutter on the bottom was used but this tends to slip aside and not cut the ridge off cleanly. A particularly effective setup used a spring-mounted duck foot chisel mounted directly behind the center of the disk.

5) Depth of furrowing out was generally 3" to 4" and was adequate in most cases. Extreme cases may require furrows of only 2" depth to as much as 5" or more. Width of bed, depth of planting, size of initial ridge, size of desired final ridge all play a part in proper furrowing depth which must be judged in each individual case and gauged somewhat by experience. There seemed to be a tendency to furrow too deeply when interplanting 7' beds.

6) Various planting and furrowing combinations and their actions were recorded on movie and still film for educational and training purposes.

7) Planting was done with two different types of rigs. Three pairs of homemade drills, designed specially for inter-row planting, planted most of the acreage. These planters were single unit, gauge wheel driven, tool bar mounted units using standard grain drill openers and distributors. There are now a number of commercially produced single unit planters on the market which would probably be more suitable because of better rigidity and lower center of gravity. Preliminary tests indicated that plates are available for these planters which will handle barley at the desired rates. One grower used fertilizer distributor units feeding hollow chisel points as openers. Depth of planting change due to bouncing of tractor made this method less suitable than others.

Several growers combined furrowing out and planting into one operation by mounting the furrowing equipment on the front tool bar and the planters on the rear one. This is a highly satisfactory method which cuts down on tractor hours and man hours needed to do the planting. With certain types of equipment it should be possible to mount both the furrowers and planters on the rear tool bar, eliminating the necessity for a dual tool bar tractor.

8) Rates of seeding in most cases were about 10 lbs. per acre on 8' beds and 12 lbs. per acre on 7' beds (based on the asparagus acre). This rate drilled about 18 to 20 seeds per foot which seemed to be about right. Rates 50% greater were tried (28-30 seeds per foot) but appeared to be too heavy.

9) As experienced in previous years, the centers into which the barley was planted was very hard and compact in several cases. In one case after the furrowing out, the disk openers of the planters were able to only scratch the surface with no more than 1/4" to 1/2" penetration. A necessary requirement for inter-row planting is that the barley be planted into an adequate seed bed, not only to promote good germination, but also to allow good vegetative growth. For this reason preplant chiseling was required in three cases in the 1960 plantings. In one case where it was not practiced root growth and hence over-all vigor seemed to be restricted by the hard ground. One or two chisels per barley row would seem to be sufficient depending on the soil condition.

10) Splitting and ridging for conversion to white seem to be the most critical operations involved in inter-row planting when it is planted early into

green asparagus. Old methods of setting equipment must be modified to accomodate the growing barley. First of all, tractor treads must be set sufficiently narrow so as not to run over the barley and tractor drivers must exercise particular care. Normal practice without inter-row frequently throws soil from the asparagus rows to the very center between rows in the splitting operation. This must be avoided with inter-row. With 8' beds this is rather easily accomplished by modifying the set of the disks and/or removing outside blades. With 7' beds (and to some extent with 7½' beds) this is more difficult. In certain cases "splash boards" or moldboards may have to be set at the outside of the disks to prevent the throwing or rolling of soil into the barley strip. In some cases, slower tractor speeds accomplished the purpose although this was not as satisfactory from an economic standpoint as using suitable equipment at normal speeds. Although splitting and ridging were accomplished on bed widths of both 7' and 8', these operations were generally more successful on the wider beds. The narrower beds are harder to work with and require more care and selection and adjustment of equipment to make splitting and ridging easy and satisfactory.

11) Only one grower had weed problems in the barley strip which he considered sufficient to require control. 2,4-D (amine form) was applied by a commercial operator on May 20. The spray rig was specially modified for inter-row work, spraying six strips of barley at a time, two nozzles over each barley strip. Weed control was only fair but sufficient to hold the weeds in check. The primary cause of poor weed kill was due to the advanced stage of growth of the weeds. This late spraying date was caused partly by a long period of strong winds in the morning, partly by the indecision on the part of the grower whether or not to spray.

12) The grains principally used for inter-row planting (barleys) are subject to the virus disease yellow dwarf when grown in the delta. Inter-row plantings have been affected only very little by this disease in the past. In 1960, one set of fields had a large buildup of aphids (the insect vector for yellow dwarf) which was followed by a moderately serious attack of yellow dwarf disease. By mid-May leaves on the lower 1/3 to 1/2 of the plants were very yellow and the plants appeared unthrifty. Despite this onslaught, the barley became very effective in preventing wind erosion and dust. Had the growth not been stunted by the disease, the barley would have been effective in dust control at an earlier date.

13) Toward the end of November, about 3 weeks after the first fall rains, volunteering inter-row barley was 4"-5" high and in stands varying from light to heavy. In addition, two islands had moderate amounts (dense stands in some places) of tall, rank, nearly mature barley which apparently had germinated from capillary moisture after the last summer weed cultivation. This was the first time in inter-row planting experimentation that this type of volunteering had been seen. Disking of fields after fern was chopped greatly reduced the barley population, but where stands had been heavy considerable barley remained although somewhat chopped and partially uprooted. On one island disking of chopped fern was not practiced and so the volunteer barley went into the winter season with no attempt at control. Before the calendar year was completed most fields had been subjected to some flooding but the results in terms of barley volunteer control must wait until the spring of 1961.

14) Costs for inter-row planting in 1960 were to be determined by bills submitted by the cooperating growers in the public experiment. This accounting has not been completed but it would appear that costs can vary from about $1 to $5 or so per acre depending on normal management practices, equipment available, weediness, barley volunteer, and other factors.

15) A complaint against inter-row planting which has been brought up in previous seasons was voiced by asparagus harvest labor on at least two of the islands. Workers complained of getting their feet and trousers wet while walking through the damp barley on dewy mornings. This complaint did not produce any labor trouble. Should this become a serious problem, growers might have to issue some sort of protective clothing.

16) On the other hand, workers on at least three of the islands indicated appreciation for the inter-row planting. They preferred to work in the interplantings on windy, dusty afternoons because of the superior working conditions.

17) Inter-row proved to be of value to the growers in ways other than in controlling dust. In the section on "Inter-row effectiveness" below, three other benefits that occurred on one or more islands are described. In brief, these are: 1) fewer reridgings were necessary during the white asparagus season when the beds were protected from wind erosion by inter-row planting; 2) inter-row prevented a drain ditch from filling by windblown soil; 3) better quality white asparagus was obtained in inter-rowed asparagus after a severe wind and dust storm.

18) One grower on a low organic matter "semi peat" attempted, for the second year in a row, to interplant into 6' green asparagus and maintain the grain through the ridging process. As in 1959, he was unable to maintain the grain through the conversion procedures because of physical lack of space and soil.

On the basis of the 1960 inter-row planting program certain general conclusions on the management of inter-row planting can be drawn. They are in addition to those made in previous years which do not conflict. They are briefly:

1) The planting period should be about the middle of March to the end of the first week in April, the earlier the better.

2) Single-drilled rows down every center (between asparagus rows) are sufficient for protection and are more satisfactory from a management standpoint.

3) Seeding rates of 18-20 seeds per foot appear to be optimum. This amounts to about 10 lbs. per asparagus acre in 8' beds and 12 lbs. per acre in 7' beds with most barleys.

4) Seeding should be preceded by furrowing out the center to a depth sufficient to make ridging for white asparagus production possible without disturbing the barley or leaving it on a steep-sided ridge. The furrow should be as wide and flat bottomed as possible and can be made either by disks or properly designed flat-bottomed shovels.

5) Particular care and attention must be given to the splitting of beds and ridging to white in the presence of inter-row strips. Equipment may have to be readjusted or modified from standard techniques to prevent destruction of the barley.

6) The narrower the row the more difficult it is to manage asparagus with inter-row planting. Inter-row planting can be done on row widths of 7' and greater, but 7' beds require more care and attention to details and, in some cases, more equipment modification to be successful.

7) Barley volunteering in the winter, not considered a serious problem (and in many cases no problem at all), can be more easily managed in the spring if methods used to get rid of the barley in the summer and subsequent cultivations are aimed at keeping the barley in the centers between the asparagus rows as much as possible.

8) Ease of management later in the season is increased where careful attention is given to the initial furrowing and planting operations. The drilled rows should be accurately in the center between asparagus rows and straight.

A tour of inter-row planted asparagus was held on June 4, 1960 for the County Peat Dust Evaluation Committee to acquaint the members with the project and to show them the problems encountered in inter-row planting as well as its effectiveness in dust control. A copy of the tour itinerary including pertinent facts concerning each planting is attached on the next page as a part of this report.

Inter-row planting now seems to be developed sufficiently for widespread use and can be used in nearly all white asparagus grown in peat soils. This does not mean, however, that detailed recommendations of just how and what to do can be given in every case. Differences in soil, weediness, drainage, age of beds, height of ridges, and equipment available make it impossible to recommend in detail every step that will work for all farmers. Growers must work out many of these details for themselves within the broad outline which can now be laid down as a guide.

At the end of 1960 a farmers bulletin on inter-row planting using the new technique worked out this year was in preparation.

Inter-row effectiveness. Dust control was strikingly demonstrated on several of the plantings. Inter-row in other fields failed to show much usefulness, either because there was little dust from the control fields as well, or because unexpected unusually early conversion to white asparagus destroyed most of the barley when it was very young and weak. In all cases, adjoining asparagus fields, similar in nature to the interplanted field, were left non-interplanted as controls. Inter-row planting was evaluated by both observation and measurement. Measurements included wind velocity measurements (see report by H. B. Schultz on climatology phases of this project), dust measurements, degree of filling of ditches by wind erosion, and numbers of re-ridgings necessary due to wind erosion. Evaluation by observation included visual observations of dust both from the ground and in the air, changes of bed shape due to wind erosion, improvement of asparagus quality, and opinions expressed by growers and farm workers.

SAN JOAQUIN COUNTY BOARD OF SUPERVISORS

PEAT DUST EVALUATION - ADVISORY COMMITTEE TOUR OF

INTER-ROW PLANTING EXPERIMENT

Saturday, June 4, 1960

Leave Chamber of Commerce - 8:00 A.M.

1st Stop

STATEN ISLAND
Cooperator - Claire Davis

- Asparagus - 7' beds, 4 years old
- Inter-row - planted 4/19 - 4/21 into white beds
- Planting originally scheduled for late March or early April was delayed a few days because of growing slime problem. Then delayed until after ridging for white believed to be imminent but was actually delayed considerably
- 156 acres interplanted

2nd Stop

TERMINOUS
Cooperator - Atkins-Kroll Co. (Dick March)

- Asparagus - 8' beds, 5 years old
- Inter-row - planted 4/5 - 4/6 into green asparagus
- Has never been ridged for white. Mixture of barley and wheat to remain green longer to forestall thrip problem. Another 100 acres planned for inter-row was plowed out this spring
- 96 acres interplanted

3rd Stop

RINDGE TRACT
Cooperator - Hayes-Rule

- Asparagus - 8' beds, 6 years old
- Inter-row - planted 4/22 - 4/30 into white beds
- Mixture of barley varieties used because of late planting. Recently re-ridged
- Variety - fertilizer - gibberellin experiment - for testing these factors on late plantings
- 375 acres interplanted

4th Stop

KING ISLAND
Cooperator - Dell Aringa Brothers

- Asparagus - 8' beds, 5 years old
- Inter-row - planted 3/24 - 3/25 into green beds
- Recently re-ridged. Barley poorer than normal due to aphid, yellow dwarf disease, root rot and dry soil. Even so, highly effective.
- 104 acres interplanted

Lunch in Stockton at Turks

A. B. Carlton
Davis, Soils and P. N.

January 16, 1961

Notes on observations:

On May 4, barley inter-row was observed during a strong, gusty wind at an angle of about 30°-45° to the rows. Barley planted March 24, was 4" to 7" shorter than height of the ridge. Some dust was blowing from the asparagus and no noticeable difference between inter-rowed fields and controls could be seen. On May 16, in the same fields, the tallest plants were up 2" to 3" above the tops of the beds. With the wind at 45° angle to the rows, some dust was caused by occasional gusts as well as by a few "dust devils". The positive effect of inter-row on wind erosion control was definitely but not strongly apparent. Dust out of inter-rowed fields from gusts was estimated at 50% of control dust and "dust devils" were cut down slightly. The following day however, while observing these fields from the air, dust from the control fields was estimated at 5 to 10 times that from the interplanted fields.

Observations on other inter-row plantings gave essentially the same picture. When the barley reached the height of the ridges or a little taller, some control of dust could be seen. By the time the barley was 24" tall (10"-12" above the tops of the beds) a very striking degree of control could be seen whenever the wind was sufficient to raise dust in the control fields and the inter-row was in reasonably good stand. This held true both for row orientations parallel to the wind and at angles to the wind. No adequate observations were made with 90° wind orientation but previous experience indicates that inter-row is very effective in 90° wind. It was noticed that fields with full grown inter-row contained fewer and smaller "dust devils" than adjacent controls and that when a "devil" moved into an inter-rowed field, it was either extinguished or greatly diminished.

Experience has shown that asparagus fields are particularly vulnerable to wind erosion for a period of several weeks after the end of the harvest season and the beds are split open to allow the asparagus to go to fern. It has been felt that inter-row plantings should be left standing during this period to afford the maximum of control. Where this was done in one case in 1960, evidence in form of soil drifts showed that even relatively poor interplantings very materially cut down erosion and soil drifts during this critical period.

Change in asparagus ridge or bed shape can be a criterion for wind erosion occurring in white asparagus fields. When wind is parallel or nearly so, severe erosion changes the cross section of the asparagus ridge from a rounded, inverted "U" shape to a sharp peaked shape similar to a volcano or flattened, inverted "V". Very serious wind erosion occurred on the control fields on one of the islands as indicated by the characteristic "blown down" beds. Adjacent fields protected by inter-row planting were in perfect shape and showed absolutely no evidence of wind erosion. Although not witnessed by the writer of this report, other evidence would indicate that similar protection from bed-shape loss was afforded by inter-row planting on two other islands.

No inter-row planting this year was planted early enough to protect green asparagus quality from wind erosion. However, in one instance white asparagus quality was protected during a severe wind and dust storm. Quality of asparagus from inter-rowed beds remained normal while poor quality and many culls were harvested from the badly eroded fields unprotected by inter-row. Erosion hed uncovered and damaged many white stalks ready for harvest.

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The consensus of the growers, farm workers, and agricultural people who observed the inter-row planting trials was that inter-row planting was effective to one degree or another in controlling wind erosion and dust. The most favorable reactions came from those who witnessed plantings which were the earlier planted and consequently tallest during most of the season. Many were frankly amazed at the degree of dust control afforded by inter-row planting even in winds parallel to the rows.

Evaluation of inter-row by measurement:

The details of wind velocity measurements in inter-rowed asparagus fields are given in a separate report on this project by H. B. Schultz. In general, wind velocities in inter-row and control were measured a few inches above the tops of the beds by recording cup-type anemometers. Wind velocity reduction in the order of 40% was obtained in the inter-rowed fields compared to the controls. Work in 1959 (see p. 128) indicates that a reduction in wind velocity of 25% will go a long way toward reducing the dust.

Severe erosion from control fields on one island (the same fields which produced the poor quality asparagus and the badly eroded beds) caused sufficient drift and surface creep to clog a drainage ditch at the lee edge of the fields. The open drain was about 4' deep, about 4' wide at the top, and about 18" wide at the bottom. It extended along the lee edge of the block of interplanted fields as well as along the lee edges of the control fields on either wide of the interplantings. After two bad dust storms, the ditch to the lee of one of the control fields was completely filled to ground level by soil drift. The ditch to the lee of the other control field was 1/3 to 1/2 filled with drift. The portion of the ditch to the lee of the interplanted block was virtually drift free right up to the boundary of the control fields.

Another indication of inter-row effectiveness is the reduction in the number of re-ridgings required during a season. Among the reasons for re-ridging white asparagus, breaking down of ridge shape due to wind erosion is one. Two of the growers reported half as many re-ridgings were required in the inter-planted asparagus. The extra re-ridgings in the unprotected asparagus were required because of wind erosion. One other grower reported he required fewer re-ridgings in his successful interplantings.

As in past years it was found difficult to get meaningful quantitative data on inter-row effectiveness with dust collectors. One problem is in finding matched fields for inter-row and controls. Fields with little or no apparent differences in surface physical structure can behave quite differently in winds near the critical velocities. Another difficulty is that the collectors are subject to local influences since their collecting areas are only 9" to 14" above the ground surface. The collectors used were the impinger type and were described in the report for 1958.

Measurement of erosion by dust collection was done on Staten Island, King Island and Rindge Tract but most of the measurements were made on King since the barley was up taller and in better stand throughout the season. Dust collectors were left in the field from 2 to 7 days per "set-out" and collected dust from one or more storms. The following tables are typical of the data obtained. The percentage column shows the percentage of dust from the inter-row fields compared to the control fields.

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Inter-row effectiveness, King 1960

Collection period	Fields compared	Dust from interplanting as fraction of control
5/27-5/31	3A , 3B	9.2%
"	1A , 2A	5.8%
"	5A , 6A	46%
"	2A , 2B	5.1%
6/7-6/9	5A , 6A	56%
"	1A , 2A	21%
"	5A , 6A	44%
6/13-6/16	5A , 6A	25%
	After splitting for fern:	
6/20-6/27	1A , 2A	16%

Note: Fields 2A, 3A, 4A, 5A were interplanted. Remainder were controls.

The data above would suggest that inter-rowed field 5A was less effective than inter-rowed field 2A and that the fields in general became less effective as the season wore on. This is probably not true, at least to the extent indicated by the data. For some unknown reason, with little or no apparent dust arising, the inter-row collectors contain nearly as much dust as the controls. When the wind becomes strong and the dust begins to move in large quantities (at least in the control fields), the inter-row cans still collect relatively little dust but the control cans collect a lot. In the instances of high inter-row efficiency shown above, relatively large quantities of dust were collected whereas only small quantities were collected where efficiencies were poorer.

Inter-row effectiveness, Rindge 1960

Collection period	Dust from interplanting as fraction of control
5/31-6/7	185%
6/20-6/27	60%

The above data were taken from the latest planted inter-row on Rindge Tract (planted 4/30). During the first collection period the barley was not up high enough to give any control. The dust data indicate that the inter-rowed field was more erodible than the control field. However, by the second period when the barley was about 20" tall the inter-row had reduced the dustiness about 2/3.

Other collections in the first half of June on Rindge and Staten showed no significant differences in dust collection between inter-row and control. This was probably due to the short stature and sparse nature of the barley.

Windbreaks

Bamboo. At the start of 1960 the experimental bamboo windbreak looked very poor and had made little recovery from the killing frost of 1958. During the year little attention was given to the bamboo, it was not watered nor was it kept free of weeds. By mid-year most of the plants were sending up culms but few were heavy or tall. The plants looked healthy but small. By the end of the year the stand was thick and the average height about 4', taller than any time previously. Several plants were 6' tall. In general, the windbreak appeared more healthy and vigorous than at any time since planting. The spring of 1961 should be a critical period in determining whether the windbreak is likely to establish itself and grow tall enough for wind control. Normal cultivation of asparagus has continued to keep the bamboo from spreading out of its bounds.

Other windbreak material. Arizona Cypress. The Arizona Cypress trees are now 12'-18' high and have shown little growth in the past two years. They continue to remain healthy but have probably reached their maximum height. They would be suitable windbreak material in the delta where a fast-growing narrow windbreak is needed with an effective height of no more than 12'.

Poplar, Eucalyptus. The possible commercial value of windbreaks of poplar and eucalyptus for pulpwood was investigated. If some cash return could be realized in addition to their wind erosion protection feature they would be more likely to be accepted if other problems could be worked out. Present prices paid for these pulpwoods are $6 per ton for eucalyptus and $4-$4.50 per ton for poplar or cottonwood delivered in the Bay Area. No logs less than 4" diameter are accepted. Pulpwood buyers prefer to buy chips rather than logs so a chipper would probably have to be set up in the delta. Even though eucalyptus can grow as much as 30' in two years after cutting, some method of selective cutting or multiple rows per windbreak would have to be instituted in order to maintain windbreak effectiveness. On the whole it would appear that the small return would not be an important factor for a grower or landowner in deciding whether or not to use windbreaks.

New Crop Possibilities

As has been mentioned in previous reports, 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.

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Christmas tree variety trial. Only the three varieties carried over from last year as having any possible merit are reported on.

Of the three, Douglas fir appeared to hold the most promise in 1959 although the shape was only fair to good. At Christmas season in 1960 the Douglas fir trees were 2' to 6' high with about half of them 4½' to 6'. They had dense foliage and good color but poor shape. The main growing points on all trees had been inhibited or killed, providing no main central leader. Douglas fir did not make suitable Christmas trees in the delta.

Scotts pine did not grow much during the past year and again had the undesirable characteristic winter yellowing. They do not appear to be suitable for Christmas tree production in the delta.

The redwood trees were 10' to 11' tall or 10' to 15' tall depending on whether they were 5 or 6 years old. They continued healthy and in good shape but had the same drawback as Christmas trees as explained in the 1959 report, p. 140.

It must be concluded from this experiment that growth rate, shape attained, weed problems, and other factors do not point to Christmas tree culture for commercial purposes on the delta islands as likely to succeed.

Blueberries. The only work with the blueberries in 1960 was an attempt at chemical weed control. Dalapon at 6 lbs. per acre was applied to the entire area except an 18" to 24" diameter circle around each plant. All weeds except nut grass were well controlled. The lack of competition however, apparently stimulated nut grass growth which became very dense and rank and was as serious a problem as the mixed weeds had been before. In 1961, weed control by black plastic sheeting will be tried.

Irrigated pasture. The 1960 work consisted of advisory work by the farm advisor on cattle management problems in the delta. More irrigated pasture acreage was put in at his suggestion. Pastures four years old have shown only minor weed problems but are beginning to show symptoms believed to be caused by excessive salt. These symptoms are the loss of legumes from certain spots, but not grasses. Surface irrigation by flooding or sprinkling may be required to prevent excessive salt buildup. Irrigation is presently by sub-irrigation through mole drains.

Soil Temperature Measurements

Soil temperature measurements begun in 1958 and described on pp. 113 and 141 were continued. Yearly highs of 80°F. at 12" and 99°F. at 4" were recorded. Lows were 48°F. at 12" and 40°F. at 4".

Experiments in 1959 with plastic soil mulches in the winter showed rapid rises in soil temperatures. These elevated temperatures persisted for some time after the plastic was removed. This held the prospect of economically heating asparagus beds in the winter to force early growth when the market value for the vegetable was high. Experiments in February and March of 1960 were run to determine if this might not be feasible. Prime beds of asparagus were selected with uniform stand counts. Clear 2 mil Visqueen polyethylene sheeting in 50' lengths, 4'2" wide, was put on the beds and held down at the edges with soil. In some cases the plastic was pulled fairly tightly across the soil. In others, the plastic was "baggy" to allow more spear growth under the plastic. In one case the plastic was removed after the soil temperature became elevated. The loose plastic was maintained longer while spears continued to grow and curl under it before removal. It was then replaced after a few days. Temperature measurements at crown depth (7") were made at regular intervals. Spears were harvested and weighed at regular intervals according to commercial standard (9" spear, at least 7" green).

The soil temperatures obtained from one of these experiments are shown in the table below.

Asparagus bed temperature, Empire Tract

Temperature °F., 7" depth

Date	Control	Plastic	Diff.	
2/5	52.0	52.0	0.0	plastic installed
2/8	55.5	57.0	1.5	
2/10	53.5	58.5	5.0	
2/11	53.5	62.0	8.5	plastic removed
2/12	50.0	55.0	5.0	
2/15	49.5	51.0	1.5	
2/18	50.0	51.0	1.0	
2/21	49.0	49.0	0.0	

Within 6 days, the plastic had caused a rise in temperature of over 8°F. above normal. It was 10 days before this extra heat was dissipated at the 7" depth. Other data show essentially the same pattern. The effect of this temperature rise on the early production of asparagus is shown below. The yields shown are from the plot whose temperatures are listed above.

Yield data, 4' beds, Empire Tract

	Accumulated wt. of spears harvested, gms.	
Dates	Control	Plastic
2/12	0	189
2/15	57	374
2/18	111	374
2/21	152	479
2/24	240	652
2/27	315	1032
3/1	430	1109
Totals to 3/1	430	1109

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By March 1, the plastic covered plot (plastic removed the day before harvest began) had outproduced the control plot by 679 grams. This rate is 364 lbs. per acre extra due to the plastic. This is a sizeable production at a time of the year when asparagus price can run from 25¢ to 75¢ per lb.

Although these plots were not replicated, they were all similar and showed the same general picture as the example shown above. Temperatures in all cases rose rapidly under the plastic. Spear emergence began earlier and in larger quantities. These experiments strongly indicate that under certain conditions plastic sheet heating of asparagus beds might become commercially feasible. Further experimentation will be needed to explore the method further.