Form C-10m-10,'57(171)

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 December 31, 1962

Annual Summary Statement of Progress for year ending Dec. 31, 1962
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 of previous years. This comparison indicated 1962 was essentially like the years prior to 1961 when massive dust control measures were first used in the Delta. Examination of the acreage and quality of inter-row planting indicated that only a low level of dust abatement could have been expected. As a result, the 1962 data were combined with the pre-1961 data to form a "no dust control" picture of dust storm distribution and intensities. A new method of tabulating dust storm distribution throughout the year gives proper emphasis to the importance of moderate and severe storms and hence a clearer picture of the critical dust period. 1962 was considered one of the dustiest of recent years.

A number of factors sharply curtailed Delta-wide inter-row planting in 1962. As a result, only about 1/3 the 1961 acreage was interplanted and much of what was interplanted was substandard--due in large part to excessively late planting. Perhaps the largest single factor discouraging growers from interplanting in 1962 was a very substantial winter barley volunteer problem from the 1961 interplantings. This came about primarily through an unusual climatic condition coupled with lack of experience on the part of the growers. Observation of the situation led to a clearer understanding of the problem and proper management methods to minimize it. In addition, research was undertaken to eliminate the problem by other means.

Herbicidal and other sprays were tried on growing inter-row barley in an attempt to prevent setting of viable seed without adversely affecting the morphology of the plants. Amino triazole, Dalapon, maleic hydrazide, Mendok, and ammonium sulfate were used at different stages of growth. Good to excellent volunteer control was obtained with maleic hydrazide, fair control with amino triazole and Dalapon. Amino triazole severely burned the foliage at rates sufficient to reduce germination of seed.

Variety trials for finding more suitable inter-row plants were continued. Sierra and Curt oats are promising varieties. Some variety mixtures look good for the purpose of combining two or more desirable features in the interplanted strip. No useful response to N and P fertilizer placed under the interplanted row was found. No response to gibberellin at 1 ppm and 10 ppm was seen on the four varieties of grain sprayed at different stages of growth. (Concluded on reverse side)

Publications: None

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A new technique of studying subsidence using buried bench marks in the soil profile was tried. Initial results show an expansion of as much as 1 1/4" in the profile between the 6" depth and 5' depth in peat when the water table is raised to near the surface.

Grapes and irrigated pasture for cattle production continue to show increased promise for use in the Delta.

Clear polyethylene sheeting of 0.4 mil thickness was tried as an extension of the 1960 experiment using plastic over asparagus beds to raise soil temperature. The thin material used was effective in raising soil temperature and hastening onset of asparagus production but was mechanically not strong enough to withstand the rigors of the winter storms. The reason for the lack of strength was believed found and a remedy suggested.

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Dust Storms

As in previous years, observations of dust storms were made throughout the calendar year to the date of this report. The storms were classified according to severity and general wind direction in the manner described in previous reports. Last year it was anticipated that that year was the beginning of a new era in so far as dust storms were concerned because it was the first year in which massive dust control measures were undertaken in the Delta. It was further anticipated that these measures (large scale inter-row planting of white asparagus) would continue in subsequent years. The 1961 report, therefore, compared dust storm quantity, intensity, and distribution of that year with the averages of the six preceding years rather than averages of all years including the current year.

It was expected (assuming massive inter-row planting in 1962) that the 1962 storm data would be compared to the six years prior to 1961 and also averaged with 1961 to begin to build up information on the average effect of massive inter-row planting on dust storms. Such comparisons cannot be made. Rather than the wide scale inter-row planting expected (nearly 14,000 acres in 1961) only a very modest planting took place (less than 4,000 acres) and much of this was substandard. As a consequence, little of the white asparagus in the Delta was protected from wind erosion. Therefore, 1962 should properly be considered a control year with storm statistics combined with the years 1955-1960 rather than with 1962 as anticipated. This is done in the tabulations which follow.

The first storm occurred on April 14 and the last (to date of this report) was on October 12. Of the 45 storms recorded, 41 were caused by more or less westerly winds and hit Stockton and/or Lodi. Three dust storms were caused by northerly winds and essentially bypassed Stockton and Lodi to the west. One dust storm occurred from S to SE winds and missed San Joaquin County cities.

The 45 dust storms recorded for the year made it third highest in eight years of records. It was generally considered locally to be a dusty year—above average.

The following data for peak dust storms for 1962 are arranged in the same manner as reports from previous years. Statements on pages 35 and 36 of the 1956 report relative to definitions and changing standards from one year to another are applicable to this report as well as the statement at the bottom of page 184 of the 1961 report.

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Westerly dust storms hitting Stockton and/or Lodi:

Number of storms by month

	1962
January	0
February	0
March	0
April	4
May	14
June	10
July	3
August	6
September	3
October	1
November	0
December	0
Total	41

Number of storms by half-months for May and June

		1962
May	1-15	5
May	16-31	9
June	1-15	7
June	16-30	3

Tally of storms by severity:

	Total 1962	Number of storms Apr.	May	June	July	Aug.	Sept.	Oct.
Very severe	0	0	0	0	0	0	0	0
Severe	3	0	2	1	0	0	0	0
Moderate	15	2	3	5	1	3	0	1
Mild	16	1	5	4	1	2	3	0
Very mild	7	1	4	0	1	1	0	0

Distribution statistics for westerly storms: These statistics in past reports lumped storms of all categories together and showed the yearly distribution of storms by per cent of total in each month. This method of contrasting the present year with average of all pertinent years of record is being changed somewhat. First of all, total number of storms from which the percentages are figured is also shown both to make similar calculations in subsequent reports easier to do and also to give an idea of the number of storms upon which the percentage statistic is based. Secondly, since moderate and severe (and very severe) storms are of so much more significance both from erosion damage and the nuisance potential in populated areas (see p. 186 of the 1961 report) than mild and very mild storms, it was deemed worthwhile to separate accumulative dust storm distribution statistics into two categories. Consequently, the first table on the following page shows the number and percentage distribution of very severe, severe, and moderate storms combined while the second shows the statistics for mild and very mild storms combined.

Number and per cent of year's "bad" (very severe, severe, moderate) dust storms from westerly winds in each month, no massive controls:

	Number of storms			% of year's storms		
	1955-60	1955-60 + 62	1962	1955-60	1955-60 + 62	1962
March	0	0	0	0	0	0
April	7	9	2	12	12	11
May	13	18	5	21	23	28
June	32	36	6	52	48	33
July	3	4	1	5	5	6
August	6	9	3	10	11	16
September	0	0	0	0	0	0
October	0	1	1	0	1	6

Number and per cent of year's "light" (mild and very mild) dust storms from westerly winds in each month, no massive controls:

	Number of storms			% of year's storms		
	1955-60	1955-60 + 62	1962	1955-60	1955-60 + 62	1962
March	3	3	0	2	2	0
April	12	14	2	9	9	9
May	44	53	9	32	33	39
June	32	36	4	24	23	17
July	19	21	2	14	13	9
August	15	18	3	11	11	13
September	9	12	3	7	8	13
October	1	1	0	1	1	0

As was mentioned above, since the expected massive inter-row plantings in the Delta area did not materialize, the 1962 distribution statistics cannot be combined with the 1961 data. The question arises whether it is proper to combine them with the pre-1961 data to improve the "control" or "lack of dust control measures" statistics. Although no massive inter-row planting of the order of 10,000-15,000 acres took place in 1962, approximately 4,000 did eventually get planted. However, probably half or more was either poorly planted or planted so late as to have only limited effectiveness. In addition, a considerable portion of the really effective interplantings were not in the most critical areas causing dust storms in Stockton. The tables above compare storm distribution throughout 1962 with the average distribution for the years 1955-1960. Since the 1962 distribution did not materially deviate from the long-time average, it was deemed reasonable to consider it another "control" year. Therefore, the distribution statistics for all control years (including 1962) are also included in the above tables.

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The value of separating storm distribution into two tables is clearly shown by comparing the different distribution which the "bad" storms have as compared to the "light" ones. Over 70 per cent of the bad dust storms occur in the months of May and June and nearly 85 per cent in the months of April, May and June. The lighter, less objectionable dust storms are spread out over a greater part of the year. These statistics again emphasize the need for control measures that are effective against spring dust sources.

Northerly dust storms generally by-passing Stockton and Lodi:

There were only three storms in this category in 1962, two in the spring and one in the fall. This is only the second year in eight years of records (the other being 1958) that moderate or severe dust storms from northerly winds did not occur.

Storm category	Dates, 1961
Severe	none
Moderate	none
Mild	5/21, 10/12
Very mild	4/20

Distribution statistics for northerly storms: The following table of northerly dust storm distribution includes all recorded storms for the past 8 years.

Number of northerly storms for 8 years (1955-1962) 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	3	4	2	2	11	4
May	1	3	3	1	8	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	1	2	1
October	0	5	3	3	11	6
November	1	2	1	1	5	2
December	0	0	0	2	2	2

The comments on northerly storms on p. 187 of the 1961 report are pertinent and still valid.

South-southeast dust storms missing San Joaquin County cities:

One, mild on 10/4.

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Inter-Row Planting Experiments

In 1962 work with inter-row planting consisted of observing and evaluating techniques used by various growers in their field-wide inter-row plantings, observing effectiveness of inter-row planting, continued search for possibly better plants to use for inter-row planting, and work on the barley volunteer problem.

Despite the apparent success of inter-row planting in 1961 on a massive scale, the interplantings in 1962 were less than one-third of those in 1961. In addition, a significant portion of the interplantings were too late to reach maximum effectiveness (short barley) and did not become effective at all until a considerable portion of the worst dust period (May and June) was passed.

The prime reasons for the lack of more inter-row planting appear to be the lack of any concerted campaign or drive on the part of the people, public agencies, or farmers' organizations on the one hand and certain problems encountered by the growers in 1961 on the other. The most significant problem run into by the growers and the one most conducive to discouraging growers from interplanting in 1962 was the winter volunteering of the inter-row barley. The reason for this, the experience gained, and the conclusions drawn from the observations are described below.

Barley volunteer from 1961 inter-row. As was explained on p. 190 of the 1961 report and elsewhere, a report on inter-row planting can not be completed in the calendar year because the seeds left in the ground from the interplanting might, and usually do, volunteer as a result of fall or winter rains. The effect of this volunteer in terms of any extra operations needed to control it, and its possible effect on the following year's crop and interplanting program must necessarily be considered in evaluating and developing inter-row planting as a practical dust and erosion control method.

Volunteer barley resulting from the 1961 inter-rowing was observed throughout the winter of 1961-1962 until the start of the asparagus season in March 1962, and even later in a few instances. The description of the volunteer, and the reason for it is reported on p. 205 of the 1961 report and should be consulted in connection with this current report.

When the bulk of the volunteer germinated in the first and second week of December, growers were already beginning to flood their ground or were making plans to do so shortly. Where water was already on the ground, it was too late to cultivate for volunteer control. Growers who had not flooded by that time either underestimated the potential problem of the barley or erroneously believed the flooding of their fields would be adequate to control the barley growth.

As in the past, wherever water completely covered the ground and the barley, the volunteer was completely knocked out and was no problem. Many of the asparagus fields in the Delta, however, are not level enough for complete flooding, having either high spots in them or sufficient slope that an entire end may be unflooded. In other instances, asparagus ridges may be high enough,

even in winter, and flooding shallow enough to allow the beds to protrude above the water. It is in these situations where winter volunteer became serious. Because of field wetness following flooding most growers were unable to get into their fields to cultivate the barley until late January or early February. When cultivation was attempted, the almost universally used implement was the disk. For reasons explained in the 1961 report (p. 191) disking in this damp cold part of the year was only partially effective. Prolonged very heavy rains in February further complicated the problem by keeping many of the growers out of their fields for several weeks. As a result, many growers went into the new asparagus season (early March) with varying amounts of uncontrolled barley. Since it was not feasible to work the beds after cutting began, the remaining barley began to grow vigorously in the rows. Some growers had bothersome amounts of barley in their asparagus fields as late as conversion time in April.

Nearly all growers used two to four extra diskings (diskings that ordinarily would not be needed) to control the barley volunteer, at least on those fields where lack of complete flooding allowed the barley to grow. For some growers, these diskings essentially licked the problem but for others barley continued to be a problem throughout the green market season. At least two growers sent weeding crews through the fields to hand pull tall barley clumps from the asparagus beds at this time.

Despite these problems with barley volunteer experienced by most growers, only a few experienced these problems to a severe degree. In addition, several growers experienced no essential problem despite having the potential due to heavy germination of barley. There were three significant factors involved in those cases where volunteer was no significant problem: adequate, complete flooding of fields; timely normal or extra cultivations; or the use of equipment more suited to the job of destroying barley than standard disks.

The effectiveness of complete flooding in controlling volunteer barley has been adequately covered. Proper timing of cultivations by some growers distinctly minimized their volunteer problem. Those growers who brought the barley under partial control in December prior to flooding with one or more cultivations had distinctly less trouble with volunteer later. Another timely cultivation during a dry spell in the winter all but eliminated the remaining barley. Growers who did not tackle the barley before flooding and neglected to cultivate it at the earliest opportunity after flooding ended up with a moderate to severe problem later on.

In watching the operation of a disk harrow working over volunteer barley in the winter, it becomes apparent that this device leaves something to be desired. Although it chops and buries the barley to a certain extent, still it does not completely bury the barley as a plow would do nor does it materially break up the tough root clumps. In many cases, particularly when the disk is given too little set (observed in a number of cases) the blades have a tendency to simply transplant the barley from one place to another. The main cause of the barley not dying is that the root clumps are intermeshed and imbedded in a lump of soil which prevents the roots from drying and dying even though they have been turned up on the surface. Several

growers followed a disking (which was important to loosen the soil and turn up the barley root clumps) with a different kind of harrow to break up these clumps and expose the barley roots. Both wire-tine finger weeders and rolling cultivators (rotary hoes) were used for this purpose. They were highly effective in killing the barley. The rolling cultivators were particularly effective, especially the type which can be "set" like a disk and therefore "works" the surface more.

Examination of the weather records for the Stockton area indicates that the weather condition aggravating the volunteer problem in 1961-1962 (no or only light fall rains until late November) is a rare phenomenon. Had the rains germinated the barley prior to asparagus fern chopping and disking, there would have been much less problem with volunteer because normal disking of chopped fern would have partially controlled the barley before the winter season set in.

Despite the serious volunteer problems faced by some growers in the 1961-1962 season, experience and observation would indicate that volunteer barley need not be a serious problem nor a deterrent to inter-row planting. At most, two or three extra cultivations should control it satisfactorily, even under such adverse weather conditions as were experienced this year. The steps and conditions needed to adequately control volunteer barley seem to be as follows:

1) Land that is completely flooded deep enough to cover the barley presents no volunteer problem.

2) On land not adequately flooded, winter flooding should not begin until barley has germinated and brought under at least partial control by cultivation.

3) Any serious volunteer surviving flooding should be tackled at the earliest possible opportunity during the winter, treating just the higher, drier, more weedy parts of fields if necessary.

4) If one or two diskings do not bring the barley under control due to hardy root clumps, another type of cultivator should be used, preferably a rolling cultivator (rotary hoe) used at relatively high tractor speeds.

<u>Variety-fertilizer-gibberellin plots.</u> These experiments were for the purpose of continuing the search for plants and treatments more suitable for inter-row planting than those that are presently available. The two most important characteristics desired in an inter-row plant are early vigor and growth rate (both to withstand the rigors of splitting and ridging operations in April and to be tall enough in early May for erosion control), and tall stature combined with dense leafiness (for maximum control of erosion and dust). Secondary but highly desirable characteristics are late maturity with a tendency to stay green throughout the asparagus season, the inability to germinate or grow during the fall or winter or for some other reason not create a volunteer problem, and the ability to tolerate 2,4-D sprays used for weed control in the strips. Yellow dwarf resistance or general lack of disease problems would also be a helpful quality.

Although it would be useful to have all these properties in a single variety, it may not be essential for some purposes. For instance, although the prime reason for wanting a late maturing plant is to eliminate fire hazard

(almost nil with the presently recommended varieties of Bojo and Arivat), a second reason may be of even greater importance in certain instances. Cases occur where a grower, at the time for interplanting, does not know for sure whether he will convert to white asparagus later or continue cutting green for processing. He may even interplant knowing he will stay in green asparagus, but interplant to protect his asparagus against erosion caused calls. In such cases there arises the possibility that thrips may invade the barley row when green but be forced to migrate to the asparagus spears when the barley dries. There is no reported case of this happening but the possibility exists. Later maturing grains, such as the malting barleys in these tests might be a valuable addition to an otherwise more suitable barley in a seed mix. The later maturing barley might act as a catch crop to prevent the thrips from migrating.

In view of the great concern of many asparagus growers over the volunteer problems caused by inter-row, the characteristic of non-reseeding seems to be a more important one for an inter-row plant than previously thought. All summer growing plants which have been tried (sorghums, millets, corns, sudan grass, kenaf, castor beans, and sunflowers) had the drawback of growing too slowly in the early spring, reaching adequate height too late in the dust season. In addition, most of these plants reached too great a height by the end of June to be practical. Plants tried which have grown adequately in March and April are the winter type of plant which can germinate and grow during the winter time and therefore be a potential volunteer problem.

In view of this apparent dilemma, it seems reasonable to search for other methods of volunteer control. Three have been considered. One involves the use of a plant which, when once germinated (volunteered), can be killed by use of an inexpensive herbicidal spray. This idea is covered in this section as it involves a new variety, safflower. A second involves the use of a spray on the growing inter-row plant to prevent it from setting viable seed. The third method consists of harvesting the inter-row crop and removing it from the field. The last two methods are discussed elsewhere in this report.

It had been suggested that safflower might be a suitable inter-row plant because of its tall growing characteristic and the ease with which it could be killed by cultivation or sprays if it were to volunteer. Until this year the idea seemed impractical because of the spiny, thistly nature of the plant. This year, however, small quantities of seeds of spineless varieties were obtained from the collection of Dr. Paul Knowles of the Agronomy Department. Seven varieties in all were hand interplanted into asparagus on two islands. Dates of planting were March 21 and March 26. The six varieties tried had the designations 1958-293, 1958-294, 1958-295, 1958-296, 1958-318, 1958-319, 1958-321. Three weeks after planting, the safflowers were only 1½"-2" high whereas the grains were mostly 4"-6" high after the same period. The earlier planted safflower in 8' beds withstood the conversion to white asparagus satisfactorily but the later planted trial on older 7½' beds sustained very considerable damage estimated at greater than 75% loss. Relatively low loss occurred in grain interplanting in the same operation. By May 14, the beginning of the worst part of the dust season, the safflower was highly variable in height, mostly 12"-19". On the same date the adjacent interplanted Bojo barley

was 26"-28". By the end of May the safflowers were of adequate inter-row height--mostly 22"-30"--and continued to grow to about 32"-36". Varieties 1958-294 and 1958-293 appeared most suitable in that they had the fastest early growth, were the tallest, and had more uniform density top to bottom. Variety 1958-293 particularly was more dense in the middle and lower parts due to lower branching. Later on, by mid June, however, variety 1958-321 was the tallest and had the greatest density and leafiness near the ground. At this stage, and even earlier, the safflowers exhibited a characteristic most undesirable as an inter-row plant. The strips were about 2' wide at the top, varying from 20"-28" depending on variety. This made it difficult for harvest labor to walk in the rows. On 7' plantings, walking in the asparagus would be all but impossible. By the end of June the safflowers were in various stages of bud formation and flowering and did not appear to have set viable seed. Varieties 1958-293 and 1958-321 were particularly late and would give no volunteer problem.

Varieties 1958-295 and 1958-296 were sprayed with 2,4-D on April 20 along with the barley interplantings for weed control. All plants of these two varieties were killed even though the rate of application was low enough to allow some pigweed to escape destruction. All the varieties were smooth leaved enough (except for a few individual plants which were rogued out) to permit contact without discomfort. Seed was saved from all varieties except the two killed by 2,4-D.

On the basis of this single year's test, spineless safflower would appear unsuitable for inter-row planting despite the advantage of lack of volunteering. Slow early growth and broad growing habit are the main objections. Sensitivity to 2,4-D would rule it out in those instances where growers feel it necessary to control weeds in the strip with 2,4-D sprays.

In 1961, field-scale interplanting of mixtures of barley and wheat, and barley and oats was not particularly successful although previous plot work had shown considerable promise for this technique. The idea was to provide the grain strip with the early vigor and growth rate of barley (particularly California Mariout) and the taller stature and later maturing of the oats and wheat. The failure was believed due in part to the mechanical problems of planting a mix of seeds which were so different physically and partly due to competition of the faster growing barley. In 1962 a mixture of barley varieties only was field-scale interplanted in an effort to overcome these difficulties. A 50-50 California Mariout-Rojo mixture was used to provide the early fast growth of the Mariout and the ultimate height of the Rojo. Field-scale trials were put on two islands, one planted on March 14, the other on March 26. These plantings were then compared to the adjacent Rojo and Arivat interplantings as the season progressed. Noticeable but not spectacular differences showed up between the mixes and the single varieties.

On April 25, the March 14 planted mix was 1"-2" taller and appeared superior to the straight Rojo. Just five days later, on April 30, the mix was 3"-4" taller than the Rojo and showed definite visual and measurable superiority of the mix. By the end of the first week in May this same difference in height was present with the mix being at 15"-17" and straight Rojo at 12"-13". One

week later, on May 14, the straight Rojo had caught up with the mix and there were no visual differences between the interplantings. This condition obtained for the balance of the season. It should be noted that any material superiority of the mixture over straight Rojo existed for a period of less than three weeks and this not during the most hazardous part of the dust season.

The results from the second trial planted on March 26 were essentially the same, the mixture showing only a slight advantage over straight Arivat on May 9 and none at all on later dates. A California Mariout-Rojo barley mix certainly appears to provide a certain measure of superiority during late April and early May. Whether the added height at this time of the season is worth the added trouble and expense of using such mixes of seed is problematical. Certainly such field scale interplanting should be continued and observed to determine how much value it has from a dust control standpoint.

Small variety trials of grains were again inter-row planted by hand on two islands. Dates of planting were March 16 and March 30 (March 30 and 31 for Parkland barley). Varieties tried were the same ones tried in 1961 (see p. 193) except that Swedish oats was dropped and Sierra oats and Wocus barley were added. The grains were planted at the rate of about 18-20 seeds per foot and well into moisture. Plantings of certain varieties were replicated where other treatments such as fertilizer or giberellin sprays were to be imposed. These plots were watched and measured regularly throughout the season for growth rate, height, leafiness, standability, density as a windbreak, maturity, date of drying up, lodging of heads, disease problems, and general suitability for inter-row planting. The malting barleys--Traill, Montcalm, Kindred, and Parkland--were included because of their considerably later maturity than the California feed grain varieties tried and their tendency to be tall and leafy.

The following description of the varieties as the season progressed are from the trials planted March 16. On April 4, a few days to two weeks before the normal time of ridging for white asparagus, the varieties had the same general ranking of height and appearance as they did in 1961 (see p. 193 for description) in that the barleys were generally superior to the other grains and California Mariout was the tallest (slightly), stiffest, most upright. However, contrary to observations in 1961, Arivat and Rojo both ran a close second to California Mariout, with Arivat being the stiffer and more upright. In addition, the malting barleys, Sierra oats, and Pacific Bluestem and Big Club 43 wheat were only slightly less vigorous and tall than the three top ranking barleys. Throughout the last two weeks of April, California Mariout continued to be superior in height and stiffness over all other varieties. All the malting barleys, the ryes, Wocus barley and the wheats were generally inferior during this period, being 6"-7" shorter than California Mariout. Although shorter than California Mariout by several inches, Rojo, Arivat, Sierra, and Curt were noticeably better than the others. Onas 53 wheat did poorly relative to the other wheats when compared to its performance in 1961.

At mid May when it is highly desirable for the interplantings to be at least 20" tall and preferably more, only five varieties attained this height--Curt, Arivat, California Mariout, Rojo, and Merced rye. Despite its height (22"-29") Merced rye lacked sufficient leaves and tillering to provide

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an adequately dense windbreak. Kindred and Sierra were the only other varieties closely approaching this desired minimum height. Several barley varieties had mild to heavy attacks of aphids at this stage (including Arivat and Rojo) and mild yellow dwarf disease. By May 21 (one to three weeks into the worst part of the dust season) only Curt, Sierra, Arivat, Rojo, and Merced had surpassed California Mariout in height—then 21"-22". Most of the remaining varieties were about as tall as California Mariout except that Traill, Parkland, Wocus, and Onas 53 were considerably shorter. Anything shorter than California Mariout at this late date is too short or slow to be suitable as an inter-row plant.

Notes made at mid June ranked the varieties as to their suitability at that time. Height, density, and other factors used for estimating usefulness for inter-row planting were considered.

1) Most suitable—Sierra, Rojo, Arivat, Traill, Kindred, in that order.
2) Close seconds—Pacific bluestem, Curt.
3) Perhaps suitable for special purposes—rye (3½'-4' at this time).
4) Least desirable (other than 5))—Big Club 43, Onas 53.
5) Undesirable—Wocus, Parkland, California Mariout—too short.

Although the varieties varied considerably in their state of maturity and dryness by the end of the season (June 25), all had set viable seeds by that time and none were so dry as to be considered a fire hazard. Rojo and California Mariout were the dryest and the oats were the greenest.

Observations of the second trial planted on another island on March 30 showed similar properties of the various varieties with the following exceptions. The performance of Parkland and Sierra was relatively much better on this second plot. For example, during the last half of April, except for California Mariout, Sierra and Parkland were both taller than all other varieties although this superiority over Rojo and Montcalm was not large. By mid May none of the varieties had attained the desired 20" height, presumably due to the two week later planting date than the first plot. With one exception, California Mariout's height of 14"-16" was closely approached only by the same varieties that attained 20" in the first plot. The exception was that Curt was replaced by Sierra which had about the same height as Arivat and was very leafy.

The mid June ranking of the varieties in the second plot differed somewhat from the first plot as follows:

1) Best 4—Rojo, Arivat, Sierra, Big Club. Sierra perhaps best being stiffest, tallest, most dense, perhaps too dense for parallel wind.
2) 5th—Curt oat close 5th—equal or near equal to Rojo and Arivat.
3) Next—malting barleys generally inferior to 1) and 2), principally due to uneven growth and stand, also poor density due to lack of tillering where stand good.

At the end of the season, maturity and dryness in the second plot were essentially the same as in the first plot but slightly less dry.

It was felt that the difference in variety performance between the two plots (particularly Parkland barley and Sierra oats) was due more to differences in soil and moisture than to the differences in planting date. This experiment emphasizes the importance of getting inter-row started as early in March as possible in order to have effective interplantings in time for the May dust period.

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In choosing a plant for inter-row planting, a variety must be picked which has acceptable qualities throughout the growth period and high qualities throughout as much of the period as possible. Although California Mariout has outstanding growth rate at the beginning, its mature stature during the bulk of the dust season is so inferior to other grains as to make it generally unsuitable. Likewise, although several of the wheats have very desirably tall stature during at least the latter part of the season, their slow growth rate is a severe drawback.

All things considered, Rojo and Arivat still seem the most suited for inter-row planting, with Rojo being slightly better than Arivat.

Because of the generally slow early growth rate, the nature of the windbreak provided, and adverse final height (up to 4'), Merced and Svalof Fourex ryes will be dropped from further testing.

Since the four malting barleys are all similar, the least suitable, Kindred and Montcalm, will be dropped from further testing.

Although Pacific bluestem did not perform well in 1961, it was considerably superior to Onas 53 in 1962. Therefore all the wheats should be tested another year.

Likewise, Curt oat performed poorly in 1961 but was one of the best non barley grains in 1962 so it will be retained in the testing program.

Phosphate fertilizer was again tried to provide early vigor and growth to slow growing grains and added height to a fast growing grain (California Mariout). Since there was no response in last year's tests when the fertilizer was both side dressed and planted with the seed, it was decided this year to place the fertilizer under the seed. This was done by drilling it in with a Planet Jr., planter prior to planting the seed. In addition to a relatively high phosphate rate (45# P_2O_5 per acre), various levels of nitrogen were tried by using the three following phosphate fertilizers: 0-45-0, 16-48-0, 16-20-0. With phosphate held constant at 45# P_2O_5 per acre, rates of nitrogen were none, 16, and 36# N per acre. The tests were done on two islands and two planting dates and were incorporated as part of the variety trials. In both plots no fertilizer response was evident at all until a month after planting (i.e. mid-April on one plot and the end of April on the other). Clearly, fertilizer was of no benefit in providing taller, more vigorous plants at conversion time (normally mid April). There was no height response by California Mariout due to any fertilizer on either plot at any time throughout the season. After a month from planting, this variety responded slightly to fertilizer by a darker color, slightly thicker, more uniform stand, and stiffer leaves.

A month after planting, the other fertilized barleys showed little or no height response but were darker in color and had a tendency toward stiffer, more upright leaves. At this stage the fertilized Onas 53 was also greener with stiffer leaves and the earlier planted Onas was about 1" taller than non fertilized Onas.

By mid May none of the barleys showed any fertilizer response. At this time, Onas 53 showed a marked response in terms of stand, density and general vigor. Height increase, however, was only 1"-2" and the Onas was still far shorter than the unfertilized barleys.

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It would seem from this and previous ferti izer trials that the use of fertilizers in general for the purpose of materially increasing early growth rate or final stature of inter-row plants is not practical. This does not rule out the possibility, however, that there may be individual cases where fertilizers might be advantageous because of a low nutrient level in the soil (for example in very sandy soils).

As a result of the conclusions drawn from the 1961 experiments with gibberellin sprays on grain, the experiment was modified in 1962 by treating the grain at earlier stages of growth. In addition, the high rates of 100 ppm and 1,000 ppm were discarded because of the economic impracticability even if those rates were found to be effective. California Mariout barley was treated at three stages of maturity with two levels of gibberellin spray viz. 1 ppm and 10 ppm. Sufficient spreader-activator X-77 was added to wet the leaves well and these plants were sprayed to run-off. The stages at which the barley was sprayed were as follows: 5 leaf stage plus one 2 leaf tiller; 6 leaf stage, no tillers (different plot); very early boot. At no stage of growth could any response be seen or measured. It must be concluded (from this and previous experiments) that it is impractical, if not impossible, to improve present varieties for inter-row planting purposes by means of gibberellin sprays.

Volunteer control by herbicidal sprays. This experiment was undertaken to explore the feasibility of using sprays on the growing inter-row grain to solve the volunteer problem by preventing the plant from setting viable seed. The materials at the rates used should not adversely affect the morphology of the plant for the purpose of inter-row planting. Further, it is essential that the material, under the conditions used, can be cleared for use under pesticide laws and policies. It is also necessary that the cost of material, at the rates used, is not prohibitive if the spray method is to be used in place of the cultivation method.

The trials were set out in relatively uniform inter-row barley (Rojo) in locations on two islands where lack of adequate flooding allows vigorous volunteering. Such irregularities as existed in stand and growth were noted in case discrepancies in the results showed up later. An extensive trial was set out on King Island and a smaller trial with two materials only was set out on McDonald Island. Each treatment consisted of 50 linear feet of inter-row barley carefully hand-sprayed. All treatments were duplicated in a block adjacent to the first block, but randomized. The order of treatments in the first block was serially by material, concentration, and date. The description of the King Island experiment and results follow.

Five different materials were tried in the King Island barley volunteer control experiments. The two herbicides, Dalapon and amino triazole, were tried because of their effectiveness against grasses. It was felt that there might be low concentrations of these materials which would not affect the plant too much but might in some way upset the reproductive process. The plant growth regulators, Maleic hydrazide and Mendok, (Mendok is the Rohm and Haas name for a formulation of sodium A, B dichloroisobutyrate) were tried because of their known ability to upset the reproductive processes in plants. Maleic hydrazide is used for controlling wild oat in grain fields and Mendok has been shown to inhibit

gamete development in certain broad-leaved plants. Ammonium sulfate was used because of the suggestion that this salt, as a spray, may have prevented grain set during an experiment.

Several concentrations of the materials were used and spraying was done on four different dates (stages of barley maturity). However, no strip of barley was sprayed more than once. That is, there were no treatments which consisted of periodic sprayings over a period of time thus blanketing an interval of time or maturity.

The following table lists the rates per acre used with each material and date and stage of maturity of the barley.

Pounds per Acre of Each Material Sprayed on the Barley a)

Material	May 18 stage 1)	May 22 stage 2)	May 26 stage 3)	May 28 stage 4)
Amino triazole*	1/2, 1, 2	1/2, 1, 2	1/8, 1/4	
Dalapon*	2, 4, 8	2, 4, 8		
Maleic hydrazide**	1/2, 1, 4, 8	1/2, 1, 4, 8	1/2, 1, 4, 8	
Mendok*	1/2, 4	1/2, 4		
Amm. sulfate*				25

* Rates are rates of commercial material.

** Rates are based on actual maleic hydrazide.

a) Dissolved in water and sprayed at 100 gals. per acre based on a 1' wide strip (barley spreads out when drilled in single row). Enough spreader activator X-77 was used to wet leaves thoroughly.

stage 1) 50% emergence of heads on all stalks 12" high and taller. Emergence counted if half or more of awns were loose from terminal ligule. The most mature were not yet in milk stage.

stage 2) 80% emergence. (see stage 1) for definition.) Emerged heads ran from flowering to very early milk stage.

stage 3) 95%-100% emergence. Heads ran from late flowering to milk stage.

stage 4) 95%-100% emergence. Heads ran from flowering to early soft dough. Most were in milk.

All spraying was done early in the morning when it was cool and the wind calm. At least three passes were made for each treatment to insure complete and even coverage. Both sides and tops of plants were sprayed. Commercial application would probably not be as efficient and larger rates might be needed.

It was anticipated when the experiment was set up that one or both of two methods of evaluation would be used. The first was harvesting seed from the various treatments and determining germination rates. The second was to observe the actual volunteer conditions in the field if the opportunity arose the following fall. As a consequence, representative samples of grain were harvested from

the plots at the end of June. These samples were hand-threshed, screened, and partially winnowed to remove most of the trash. This procedure posed a considerable problem. Since the mode by which the various treatments might work was unknown, it could not be assumed that the plants would set heavy, filled out, but non-viable seed. If normal winnowing and seed counting procedures were used, it was conceivable that all grains responding to the treatment might be lost (due to small size and lightness) and only full, viable seeds escaping treatment would be counted for germination rates. Thus a treatment which might knock out a high percentage of the seeds (through, say shriveling up) might show a high germination rate if usual procedures were followed.

One procedure to get around this problem would be to winnow only slightly and pick out seeds randomly from the mass regardless of their size, weight or condition. This is complicated by two factors. The first is that adequate threshing breaks large numbers of unfilled grain hulls into smaller pieces making accurate counting impossible. Secondly, all the plants including the controls sent up many late tillers, the seeds of which did not fill out.

Total yield rates of viable seed per foot or acre would be complicated by the large amount of material which would have to be harvested, germinated, and counted.

Fortunately, the opportunity arose to observe undisturbed volunteer in the field which occurred after the heavy October 11-14 rains. Because of the clear-cut results from these observations, it was not considered worthwhile to expend the necessary time to evaluate the results by the germination method in addition. It is planned, however, at a later date to count and germinate some of the samples to get a little insight into the feasibility of such method for this purpose.

The table on page 240 shows the degree of volunteering in the plots for each of the materials at the various concentrations used. For none of the materials was there any significant difference in response due to date of spraying. Therefore in the table that follows volunteer condition from all observed treatments (the two replications and several dates of spraying) for any given material and application rate are shown together for simplicity of tabulation. Observations were made on October 24, ten days after the end of the rain.

As can be seen from the table, no volunteer control was produced by either ammonium sulfate or Mendok under the conditions tried. Dalapon and amino triazole were slightly effective at the highest and two highest concentrations tried respectively. The light volunteer from one plot of Dalapon at 4 lbs. per acre is explained by the fact that this was an initially weak, poor stand of barley and would not have volunteered heavily anyway. At the rates used, maleic hydrazide was the only material which afforded a reasonable degree of control over volunteering of the barley. The control was excellent at 8 lbs. per acre and fair to good at 4 lbs. per acre. The cause of the one failure to control at the 4 lb. rate is unknown.

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Degree of Barley Volunteer in Sprayed Plots a)

Rate Lbs/A.	Amino Triazole	Dalapon	Maleic Hydrazide	Mendok	Ammonium Sulfate
25					H, H
8		L to M, L to M, M, M to H	O, L, O, O, O, O		
4		L, M, M, H	L, M to M, O, L, L, O to L	M, M, M, H	
2	M, L, M, M	M, M, M, H			
1	M, M, M, M to H		M, M to M, M, M, M		
1/2	M, M to M, M, M to M		M, M, M, M, M, M	M, M, M, M to M	
1/4	M, M				
1/8	M, H				
None	all ten control plots had H (heavy) volunteer				

a) Each entry (e.g. M, or L to M) is the observed volunteer density on a different plot. Letters stand for volunteer density as follows.
H - heavy (normal-solid stand between asparagus rows)
M - medium (about 1/3 of H)
L - light (about 1/3 of M or 1/10 of H)
O - practically none (just a few plants in 50 feet, could be contamination from adjacent plots)

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The volunteer control experiment on McDonald was less extensive, having only maleic hydrazide and ammonium sulfate at the concentrations used in the above experiment plus controls. Spraying was done on May 29 when the barley was 95%-100% headed out (emerged) with the heads varying from late flowering to milk stage (same as stage 3 of King Island experiment). Samples were harvested as on King Island. Results are tabulated below.

Degree of Barley Volunteer in Sprayed Plots [a)]

Material	Rate lbs/A.	Volunteer density
Maleic hydrazide	8	L, L to O
" "	4	L, M
" "	1	M, M
" "	1/2	M, M
Ammonium sulfate	25	M, M
Control	0	M, M

a) for explanation see table on p. 238

Ammonium sulfate again gave no control. Although the control was fair to good with maleic hydrazide at the 8 lb. rate, the response was not nearly so good as on the King Island plots. The reason for this is not known, although the barley on the McDonald Island plots was taller, more vigorous and dense than that on the King Island plots. Perhaps it was a matter of greater dilution in the plant.

Because of the probable difficulty--or even impossibility--of ever getting amino triazole cleared for use in asparagus being harvested and in view of the promising nature of other sprays, amino triazole will be dropped from further experimentation. Higher rates of AT would be impractical in any case since the highest rates used this year produced an almost intolerable amount of burning and drying on the sprayed foliage.

Mendok and ammonium sulfate will likewise be dropped because of the complete lack of response.

Dalapon at the highest rate tried was as effective as amino triazole at its highest rate in limiting volunteer but showed no readily discernible foliar symptoms or other adverse morphological changes. Higher rates of Dalapon might therefore be feasible. For this reason and because maleic hydrazide was so effective, both Dalapon and maleic hydrazide should be studied more intensively next year for volunteer control.

Delta-wide inter-row planting. For reasons mentioned earlier in this report, considerably less acreage of asparagus was interplanted for dust control in 1962 than in 1961. As a result, all inter-row planting was done by growers who had had at least one season's experience with the technique. Although twelve growers used inter-row planting in 1962, five of these interplanted less asparagus than in 1961, several interplanting only a little. As a result, only about one-third the acreage interplanted in 1961 was interplanted in 1962.

In addition, much of the interplanting in 1962 was planted too late for maximum effectiveness. Two-thirds of the interplanted acreage was planted after April 1, the date by which interplanting should be completed for best results. To make matters worse, one-third of the interplanted acreage was interplanted after the middle of April into ridged white asparagus. Experience has repeatedly shown that barley planted this late never reaches an adequate height to be fully effective and does not become even partially effective until the dust season is well underway.

Since all the growers were more or less experienced in inter-row planting and had developed their methods in other years, little new in technique was observed or learned in the 1962 season. A few changes of technique however were tried and they should be recorded.

Depth bands were used by one grower on his planters for gauging seed depth. They have been used in the past and usually found to be less satisfactory than gauge-wheel gauging. In this case, the bands allowed a planting depth only 1 1/4" which was too shallow considering the moisture status of the soil and the late date of planting. This case demonstrates the importance of an easily and fully adjustable method for gauging depth of seed planting.

Experiences by two growers showed the importance of adjusting the necessary operations to the individual need and varying circumstances. One grower, experienced in inter-row planting, found that chisels mounted on his planting tractor made accurate steering difficult and resulted in crooked interplantings. Another grower, also experienced in inter-row planting, used four duck-foot chisels per center (eight in all) mounted on the front tool bar of his planting tractor. An excellent job was produced.

Reference is made to the furrowing out method described on page 199 of the 1961 report. It was discovered that if the ridging disks were allowed to "float" (seek their own working level) rather than being rigidly fixed at some given depth, a more uniform job of furrowing out was obtained. This was due to the fact that on some passes the tractor was running in unworked centers while on others, it was running in furrowed out (or partially furrowed out) centers.

A new seed coverer was built by one grower which was superior to the usual short light chain dragged behind the planter. It consisted of a 6" length of pipe fastened to the planter by lengths of chain. Seed coverage was more complete and more uniform.

Although some of the earliest planted inter-row was rapidly drying, none of the barley had dried enough by the end of the asparagus season to burn readily, much less become a fire hazard. This is in line with experience of recent years when Mojo and Arivat have been planted rather than California Mariout and planting has taken place in March or later rather than in February.

A condition causing a considerable amount of late and therefore poor inter-row planting in 1961 was still in evidence, but to a lesser degree in 1962. This is the use of one set of planters to plant too many acres. It is aggravated when planters are loaned from one grower to another. The last grower on the string invariably is forced to plant later than he should and later than he would have been able if he'd had his own set of planters. Experience again showed that one pair of planters cannot be expected to cover more than 400-600 acres of asparagus.

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Experience on at least one acreage of inter-row asparagus in 1962 again showed the importance of planting the various fields in the same order that they will be split and converted to white asparagus later on. Failure to do this resulted in converting to white asparagus in the presence of very young, tender, short inter-row barley when the grower had other unconverted fields with barley one to two weeks further along and much more able to stand the rigors of conversion. The result was considerable loss of young inter-row barley caused by the process of conversion.

Need for adequate chiseling and loosening of hard centers was again demonstrated this year. One grower neglected to do this important operation. As a result, planters were only able to put seeds down to 1/2"-3/4" and much seed was left on the surface. The result was a poor stand and poor growth of the barley.

Lack of attention to detail—a frequent cause of trouble in past years—resulted in broken planters for one grower and the need to replant some of his acreage. In this case the relation of the diagonals of the tool bar to the ground were not vertical and horizontal as specified by the manufacturer of the planter.

An example of later difficulty with inter-row due to faulty planting was vividly demonstrated in one of the 1962 interplantings. The cause had never previously been observed. While observing re-ridging when the inter-row barley was still short and tender (this interplanting had been done late into ridged white asparagus), it was noticed that most of the barley was being either buried by dirt from disks and tires or was being run over by the tractor. Although the nominal row width was 96" (and therefore also the distance between barley rows), the actual distance between barley rows was found to run from 92" to 100". Certain pairs of rows were exactly 96", indicating the planters had been properly spaced on the planting tractor. Either one or both of two errors could have produced the results observed. The planters may not have been centered on the tool bar or the driver of the planting tractor was unable to properly center his tractor over the asparagus rows thereby causing inaccurate "guess" rows. This problem was further aggrevated by the too wide a tread on the ridging tractor. Outside to outside of rear wheels was 92½", leaving less than 2" clearance on each side to a perfectly spaced barley row. This tractor had power steering and a 1/4 turn play in the steering gear making precise steering impossible. The result of these errors, compounded on one another, was the almost complete loss of the interplanted barley.

Observations of effectiveness. As in 1961, no measurements of inter-row planting effectiveness were taken since it was felt that the value of inter-row had been adequately documented. Observations of inter-rowed and non inter-rowed fields throughout the season, however, again showed the effectiveness of inter-row planting in combating wind erosion and the resultant dust. Again the value of early planting of the barley strips was demonstrated. The late plantings, particularly the ones planted after mid April, were generally poor. Although many of the plantings seeded the first part of April eventually became fairly effective, that effectiveness was several weeks delayed compared to the barley planted in mid March. By mid May, the usual beginning of the worst part of the dust season, the mid March planted barley was demonstrating a fairly high degree of effectiveness. Later interplantings were only moderately effective at this time in holding the dust down or were not effective at all.

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Destruction of barley. Destruction of the inter-row barley is usually accomplished by trailed disks, either as a separate operation for that specific purpose or as part of regular summer weed cultivation. It is not a critical operation and little difficulty has been experienced by the growers in turning down the barley stubble. One grower experienced some difficulty this year in knocking down and killing the tough pigweed and other annuals which were in the barley row. Since the center of the cultivating disk ran right over this row, the row was hit only by the front section and not touched by the rear section at all. A nearby grower with a similar situation preceded the disking with a pass using large sweeps or vee-knife weeders. One sweep was used per barley row and they were set deep enough to lift the barley and weed roots rather than cutting them off near the soil surface. Although the tractor driver was obliged to clean the sweeps of weeds occasionally, the weeds and barley were loosened from the soil and the subsequent pass of the cultivating disk did a good job of knocking the row down and killing the weeds.

Volunteer from '62 interplantings. This season can be considered ideal for the control of inter-row barley volunteer. Heavy rains during October 11-14 were followed by a long stretch of dry weather with cloudless skies and some warm days. A few days of fog followed the rain after about a week. The wet fog allowed the germination of even whole barley beards which were on or above the ground surface. As a result, essentially 100% of the viable seeds germinated. The lengthy spell of clear and sunny weather was ideal for destroying the barley by cultivation. A number of procedures were used by growers and these will be closely followed during the winter of 1963 to evaluate their effectiveness.

Most growers used one or two diskings after germination of the volunteer to get the barley somewhat under control prior to fern chopping and disking (in most instances, the volunteer created a dense, solid carpet of barley in the asparagus field). One grower began cultivation too closely on the heels of germination and got poor control due to the damp foggy weather and the still ungerminated barley. He wound up making three passes with the disk on some of his ground. These operations killed 75%-95% of the barley. Fern disking in these fields in November killed most of the remaining barley and left the fields essentially clean of barley. Only one grower followed a disking with a pass with a rotary hoe or rolling cultivator. Several growers did not do any cultivation of volunteer barley prior to chopping and disking of fern. One grower did not even disk the fern so the barley went into the winter season unchecked.

One grower who irrigated by bringing water into the drainage ditches had heavy barley volunteer in parts of his fields in late summer and early fall. Two diskings before the October rain and one disking following it were used to control the barley.

<u>Volunteer control by harvesting barley.</u> This is the third possible new approach mentioned earlier in the report. It has long been considered that if the barley grain could be economically removed from the asparagus field this would be a satisfactory answer to the volunteer problem. However, there is only 1/16 to 1/14 of an acre of barley for every acre of asparagus. Since with regular harvesting methods about 25% of a normal crop is required to pay the cost of harvesting, this method did not seem feasible even if the inter-row barley, on an acre basis, might produce more heavily than a regular grain field. Furthermore, regular harvesters, even the smallest ones, could not move through an asparagus field in fern.

More recently it has been considered by a number of people that it might be possible to build a high speed harvester which would not thresh the barley but merely cut the heads and some stubble and throw it all into a bulk bin. This high-grain barley hay could then be used as a livestock feed as is, or with some modification. Preliminary calculations indicated that the value of the feed so produced might easily pay for the harvesting and transportation. The Rojo barley presently being recommended for inter-row planting has virtually barbless awns which should remove a potential objection by cattlemen to the use of this "hay". The idea is being developed locally by private parties in Stockton.

Cross Row Planting

Inter-row planting has not been successful on 6' plantings of white asparagus because of the necessity for tractors to travel in the only location available for the barley--in the very center between the rows. The owner of a 6' planting which will eventually be cut for white asparagus is anxious to find some workable control measure for wind erosion on this land. The problem is complicated in that the fields are long and narrow with the rows running lengthwise of the field in an E-W direction. This is parallel to the prevailing winds in May and June. The use of either permanent or annual windbreaks along the field border would be ineffective, as would periodic rows of asparagus allowed to go to fern. Because of the need for periodic cultivations or sprays for weed control, cover crops seem to be out of the question.

Annual windbreaks running across the rows and spaced perhaps 200' apart were considered and the cooperator was willing to make the necessary adjustments in cultural practice to test the idea. The fields would still be operated as single units rather than many small ones and cultivating tractors would run right over the windbreaks. A change from trailed to tool bar mounted equipment would be made to allow equipment to be lifted from the ground as it passed over the windbreak.

A material suited to this kind of windbreak must not only grow rapidly in the spring and attain a tall stature (preferably 8'-10') but must be flexible and wiry enough not to be permanently broken down by the passage of a tractor. Rapid regrowth potential when the plant is damaged would be a valuable characteristic. Tests with sudangrass in 1958 (p. 99 of the 1958 report) indicated that it might be suitable. It had early growth characteristics similar to barley but was discarded for use as an inter-row plant because of its final tall stature.

It was decided that the first year's experiment should be strictly limited because of the unknown cultural problems. It was designed primarily to observe the cultural problems encountered and the growth characteristics of two varieties. Study of spacings and erosion control would take place in subsequent years if the method appeared feasible.

The two varieties used were Piper sudangrass and DeKalb's Sudax SX-11 sudangrass-sorghum hybrid. A 200-foot strip of each was planted across the asparagus rows on April 17. Several different rates of seed were used and 2,3, and 4 drilled rows per strip were tried. At this date the soil moisture, at least near the surface, was poor. Germination readily took place but growth rate was lower than expected. The SX-11 was the faster growing of the two. By mid May the SX-11 had a standing height of 5"-6" while the Piper was

3"-4". Neither variety was thick enough, tall enough, nor stiff enough for any windbreak action at that stage.

On May 22 most of the windbreak was disked out when the asparagus beds were split open at the end of the season (earlier than normal because the beds were young). A small amount of each variety was left standing for observation purposes. By mid June the SX-11 was 30"-36" and beginning to become stiffly upright. The Piper was somewhat shorter. This contrasts with the 4'-5' height obtained in 1958 by this time.

It is felt that the disappointingly slow growth may have been due to the late planting date and lack of soil moisture. More extensive trials are planned for 1963 and a planting date of mid March will be attempted.

The tall, rank growth of the sudangrass by fall poses a problem in destroying the plants and removing the trash. The small amount left by this experiment was no particular problem but extensive sudangrass windbreaks will require special means to cope with this problem. It has been suggested that several passes with an asparagus farm chopper might cut and distribute the trash sufficiently.

Windbreaks

Bamboo. Upon examination of the experimental bamboo strip on March 19, it was found that the adjacent drainage ditch had been cleaned and the spoils dumped on the bamboo. In addition, the bamboo had been disked once and probably twice. The plants were very badly damaged, culms were broken, and stems were stripped of all or most of their leaves. The remaining leaves were brownish, drying, unthrifty and unhealthy.

Some regrowth occurred during the summer but culms were not as large or tall as previously. Inspection in September revealed that the strip had again been disked at least once. All top growth had been knocked down and killed.

Since this bamboo had suffered so regularly from some peculiarity of micro climate and/or soil condition (periodic freezing to ground by temperatures in low to mid 20's) and the obvious desire on the part of the grower for its removal, the bamboo experiment is considered terminated.

Other windbreak material. The three species of short stature willows from Michigan continued to grow in their protected mineral soil location but growth rate was slow. Soil saltiness and lack of shallow water table from which to get ample water were probably causes. Since these are still not vigorous and obviously not doing well in their present location, it is planned to transplant them to a protected location on one of the delta islands in the spring of 1963.

Anemometer calibration. Two weather bureau type 323-F cup type anemometers were obtained for the purpose of studying wind reduction patterns in the vicinity of tree windbreaks in the Delta and in the Salinas Valley. They were obtained too late in the year for any experiments during the 1962 season. They were calibrated against one another, however, in winds of various velocities they were found to have a relative accuracy of better than 1 1/2% in winds greater than 3 mph. In winds of less than 3 mph, the relative accuracy varied considerably, sometimes showing as high as 35% difference in wind passage. This

was due to a slightly higher starting speed of one of them and under nearly calm conditions one anemometer would turn while the other remained still. It is imperative with these instruments that instantaneous winds never drop below 3 mph during an experiment.

It is planned that these will be operated simultaneously as a pair, one just outside the influence of the windbreak and the other at different locations within the influence. Various heights above the ground will be used to examine the effect of the windbreak on wind profile structure.

New Crop Possibilities

As has been mentioned in previous reports, these are joint projects with the Agricultural Extension Service. The San Joaquin County Farm Advisors' Office takes the main responsibility for the field work.

Blueberries. No experimental work was done with blueberries in 1962. Observation showed continued poor growth and vigor as in past years. The consensus of those observing this experiment is that climate is the main factor against the establishment of vigorous, productive blueberry bushes. The high maximum temperature (90°-100° F, occasionally higher) and low relative humidity (of the order of 20%-30% R.H.) are far out of the range of the normal environment for blueberries. In accordance with the decision made in 1961, this experiment with blueberries is considered terminated.

Irrigated pasture. The 1962 work consisted of advisory work by the farm advisor on cattle management problems in the Delta. Pastures six years old have been kept essentially clean of weeds through good grazing management. A form of rotational grazing is now used which permits heavy grazing on rather small fields for a few days followed by a period of irrigation and rest. In the 1960 report, p. 173, it was stated that these pastures were beginning to show symptoms indicative of excessive salt accumulation. This was not surprising considering the irrigation method of subbing through mole drains. After this condition became more acute, surface irrigation with a large head of water by a modified wild flooding method was instituted. The pasture rapidly recovered and now shows little or no symptoms of excessive salt in the soil. This experience, plus the accumulated knowledge of these peat soils in general, would strongly suggest that no irrigated pasture, alfalfa, or other perennial which cannot be periodically leached, be planted without first providing for some system of surface or overhead irrigation.

Molybdenum toxicity which has plagued cattlemen on peat soils and gave rise to problems on the pastures described above, now seems to have been satisfactorily solved. Semi-yearly injections of a commercial copper glycinate formulation into the cattle seems to have cleared the symptoms completely and prevented the occurrence of molybdenosis.

Safflower. No specific research was done on safflower under this project but acreage continued to increase in the Delta assisted by a San Joaquin County farm advisor for field crops. The biggest drawback to safflower in the organic soils has been the problem of weed competition. This is less serious now than in the past with better knowledge of cultivation methods, timing, and equipment. At least one herbicide has been released for use in safflower for weed control but the expense has held its use to a minimum in the Delta organic soils. Safflower's

value in dust control was cited in the 1961 report on p. 206.

Grapes. The small commercial wine grape vineyard described in the 1961 report on p. 206 showed outstanding growth and vigor during the 1962 season. Through the help and advice of the San Joaquin County farm advisor for grapes, about half of the vines were head trained while the other half were bilateral cordon trained. The latter was tried in order to cope with the high--almost excessive--vigor shown by the vines.

Wind had posed a serious problem in the small experimental plantings by blowing the vegetative parts of the plant--leaves and laterals--to the windward (east), leaving the fruit badly exposed to the south and west sun. This would be particularly damaging to the white varieties which were planned as being particularly suitable for planting. In an attempt to find a method of solving this problem, twenty of the cordon trained vines which were exposed to the wind were selected for trellising. Four experimental four-wire trellises were constructed in an effort to train and hold the vines in more of a canopy over the berries to prevent the bad effects of excessive hot sun on the fruit. Another of the serious problems to the production of grapes in the Delta prevented any useful evaluation of the experiment. Severe 2,4-D damage to the experimental vines limited leaf size and inhibited the natural growth of the shoots under study. The damage was traced to a weed spray used in an adjacent ditch. Evaluation of the trellising experiment must await another year. The loss of this experiment served to emphasize the importance of the 2,4-D hazard in growing grapes in the Delta. The cooperator was strongly reminded that grapes were particularly sensitive to 2,4-D damage and that if grapes are to become a commercial reality, much greater care and control over the use of 2,4-D must be exercised.

The small vineyard described above and planted in 1961 was further expanded by plantings in 1962 (amounting to about twice the 1961 plantings). Quite a number of these new plantings did not take hold but those that did grew vigorously. Soil samples taken in the vicinity of those cuttings which failed showed pH's in the vicinity of 5 and lower, and saturated conductivities of 6 milli mhos or more. Despite this rather unfavorable condition, the grape experts felt the prime cause was lack of proper care--inadequate irrigation and too much soil covering the cutting causing salt burn at the leaf bud.

Subsidence

Lower Jones, Mildred, Bacon Islands. The 1961 elevation survey on these islands produced some anomalous results. The field profiles from which previous island elevations were calculated were obtained from Walter W. Weir who initiated the subsidence studies of these islands in 1922. These data have not been thoroughly studied in detail as yet and compared to the 1961 calculations but some differences are already apparent. Throughout the study since 1922, high mineral streaks found in the islands were eliminated from the calculations of average elevations. These streaks do not subside as the peats do and the study has purported to show the elevation and subsidence of the peat portion of the islands. As time goes on and elevations sink, these streaks become broader and their boundaries with the peat much less well defined. This is particularly true on Lower Jones Tract. It is evident that these boundaries used for elevation

calculations in 1961 were defined differently from previous surveys. Because of the changing nature of these mineral streaks and since they are becoming increasingly more important parts of the islands, some new method of calculating and presenting the subsidence data seems both appropriate and necessary. Perhaps the best way to reconcile the problem is to recalculate the 1961 data on the assumptions used in past calculations, then devise some more suitable and controlled method of presenting subsidence data for 1961 and subsequent years.

New methods of study. Work on the method for studying elevation changes in various portions of the profile described on p. 206 of the 1961 report (measuring magnetic field from buried energized inductors) was stopped in favor of a far simpler system. The new system consisted of buried perforated stainless steel plates attached to thin, vertical, stainless steel rods which projected above the soil surface. Relative changes in elevation were followed by measuring the height of the rod above the soil. These plates were stacked vertically, one above the other in the profile, the rods from lower plates passing through holes in all higher plates. Two systems were tried with plates at depths ranging from 6" to 5'. The first used rods fastened to the edge of the plates permitting the plates to be pushed into the undisturbed soil in the side of an auger hole. The other system had the rods grouped near the center of the disks and was installed by back filling an auger hole and placing the disks into the hole at the appropriate intervals. In both cases, the attempt was made to reconstitute the original profile in the auger holes when they were backfilled. Spoils were removed and laid out in order and each foot depth was marked off. Despite these precautions, it was found impossible to reconstitute the profile to its original density and in both cases considerable extra soil was needed to fill the holes. For this reason, the edge rodded plates pushed into an undisturbed profile appear superior.

The absence of any permanent bench mark in the vicinity--of either known or unknown elevation--allowed only the relative movements of the plates to be observed. This was done by periodically measuring the elevation of the various rods above the soil surface. No significant change in relative elevation took place until an adjacent field was flooded early in October. On October 15 the water table was found to be 9 1/2" and the profile had expanded 1" between the 6" depth and the 5' depth since September 21. On December 10 the water table stood at 14" and the profile had expanded another 1/4", or 1 1/4" since the September measurement when the water table was below 5'.

It is anticipated that the moisture status of the soil profile will be followed along with elevation changes during 1963 to see if this method can be useful in studying the soil moisture factor in subsidence.

Soil Temperature Measurements

Experiments in 1960 (p. 174-175) indicated that in February prior to the normal asparagus season, asparagus bed temperature could be raised as much as 8° F. in less than a week by covering the bed with clear polyethylene sheeting. As a result, asparagus production was caused to start more than a week earlier than normal.

The 1962 experiment was to further test the method for commercial feasibility. The main objective was to test the feasibility of using thinner (and therefore cheaper) plastic. The thinner plastic was to be observed for three

properties: 1) its ability to increase soil temperature, 2) its mechanical ability to stand the rigors of wind, weather, and mechanical damage from soil and dry plant remains, and 3) the possibility that asparagus spears might be able to penetrate it and thus eliminate the necessity for lifting the plastic in order to harvest.

Polyethylene sheeting 0.4 mil thick of the type used to cover clothes after dry cleaning was used. It was furnished by the Kordite Company. The material came in the form of a flattened tube which, when slit along one crease and opened, formed a single thickness sheet 46" wide. Four 60' long rows of 4' asparagus were covered and four control plots were staked off. The plots were covered on February 2 and 5 at which time the soil temperature in late afternoon was 46° at the 7" depth.

The thin plastic was effective in increasing soil temperature as shown in the table below.

Asparagus bed temperature, Empire Tract

Temperature °F, 7" Depth

Date	Control	Plastic	Avg. Diff.
2/5	46.0	46.0	0.0
2/7	48.0-48.5	50.0-52.0	3.0
2/17	51.0-51.5	55.0-56.5	5.0
2/20	50.0-50.5	56.0-56.5	6.0
2/21	50.0	57.0-57.8	7.0
2/22	50.5-51.0	58.0-59.0	8.0
2/23	50.0-50.5	56.5-58.5	7.5
2/26	45.5-46.5	53.0-54.0	7.5
2/28	43.5-44.5	52.0-55.0	10.0
3/2	48.5	55.5-57.0	7.5

The soil temperature increases brought about by the thin plastic were of the same order as caused by 2 mil plastic in the 1960 experiments. Difference in climatic conditions makes it impossible to make direct comparisons.

The mechanical strength of the thin material used in these experiments was not satisfactory. As splits or tears occurred in the covers, their condition was recorded but no attempt was made to patch or repair the damage. By February 7, five days after installation, one of the sheets had two lengthwise rips, 15' and 9' long. Each of these ended in crosswise rips which exposed considerable area of the bed. The cause was a strong wind the previous night. Two days later two more rips appeared on this bed leaving about 1/3-1/2 of the bed exposed and lengthwise rips about 9' long appeared in two more of the covers. This tearing continued until on February 17 40% of these three beds were uncovered by the tearing. Only one of four covers remained intact. Temperatures shown in the preceding table were taken under covered portions of the plots. By February 28, little more than 3 weeks after installation, all four covers were ripped, varying from 6' to 60'. Only 47% of the original covered area remained covered.

A. B. Carlton

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December 31, 1962

Observation of the plastic during this time indicated that the thin plastic material was basically strong since cuts and tears left by asparagus cutting knives or old protruding dry asparagus stalks did not expand nor initiate new rips. Rather, all the tearing began as a failure along the center which had been one of the edge creases of the flat tube. Despite the mechanical failure of the garment tube material in this experiment, 1/2 mil polyethylene sheet is probably suitable for this purpose if it were available in 48" widths with no weakening creases or seams.

Large uncovered areas in the "covered" plots made quantitative yield comparisons all but impossible. However, the plastic did seem to hasten spear production. On April 21, 8 spears had emerged on the covered plots and only 1 on the control plots. By April 26, the figures were 15 and 1 respectively and one spear from the covered plots was harvestable. On March 9, after all spears had been killed by a frost on April 27 and harvested there were 24 spears on the covered plots and 8 spears on the control plots. These figures are of little quantitative value except to indicate that despite the damage to the covers, the plastic covered beds were able to produce asparagus at an earlier date than uncovered beds.

In a number of cases, asparagus spears were able to push their way through the plastic covers without damage to the tip. In other cases, however, the spears either bent over after stretching the plastic tight or the tips were damaged by pushing against it. On one plot, slight nicks were made in the plastic by a knife next to every spear pushing against the plastic. In almost all these cases the spears were able to emerge through the plastic without damage. Whether the growth rate of those spears exposed to the colder outside air was appreciably slowed down was not ascertained.

More study on this method will be required before it can be determined if it might be commercially practical.