

JOJOBA-

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LIQUID WAX extracted from jojoba nuts has a variety of potential uses including use in the manufacture of cosmetics, pharmaceuticals, linoleums, and lubricants, and as a substitute for sperm whale oil. While the potential of this wax has never been disputed, no attempts have been made to establish commercial plantations of jojoba. This is partly because it has not been possible to predict with any degree of confidence whether the culture of jojoba would be economically profitable. While guesses can be made as to the approximate price at which the wax could sell, no information has been available about the yielding ability of jojoba under cultivation.

Growers considering such a venture will be interested in the Coit plantation of jojoba in Vista, California as a unique source of information. After serving for about 19 years as a pilot demonstration plot (as well as a testimonial to the vision and dedication of Dr. J. B. Coit to California agriculture), the land on which the Vista plantation was established is soon to be developed for non-agricultural purposes. Therefore, a summary of the information extracted from the nursery to date will provide a useful record until data from more recent experimental plantings of jojoba in other locations are available. This may also be of interest to people who have obtained jojoba nuts or cuttings from Vista.

The Vista plantation of jojoba was the second known attempt to establish such a nursery in southern California. The first one was made in 1944, at Arlington, California, on about half an acre of land on the J. G. Eddy farm

Graphs 2 and 3 compare indirect measures of water use under close and normal spacings. Graph 2 shows that in close-planted plots soil moisture began to be depleted at the 18-inch soil depth about 8 to 10 days before it was in normally spaced plots. At the time of the first variable irrigation, block readings were considered critically low (below 30 microamperes) for close-spacing but were 50 to 60 microamperes for normally spaced plots. (Graph 3 indicates that soil water at the 18-inch soil depth apparently was allowed to go a bit too low just before the third variable irrigation. This may have been caused by plant roots reaching well within the deeper soil zones and extracting water from that area, so the plants were slower to show visual symptoms of plant moisture stress.

Water use

Water use between the third variable irrigation (late July) and the final (uniform) irrigation indicated that the plants were nearing maturity and were slowing in their overall use of soil water. Visual symptoms of plant moisture stress were not very apparent before final irrigation except for the firing of lower leaves. To ensure maximum translocation of nutrients and organic compounds from plant to seed, however, one last irrigation appeared necessary in early August. With everything considered, visual plant symptoms in the stressed plots compared well with information obtained by gypsum (moisture) blocks installed within those plots and with ET measurement from nearby grass-covered lysimeters.

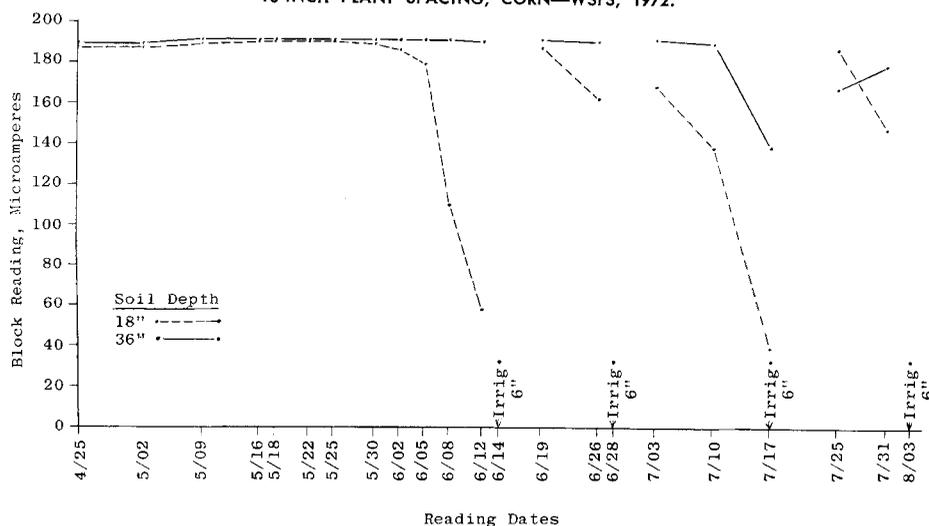
A study of average yield components, from the standpoint of moisture stress, showed that the number of barren stalks

was increased by the second stress period and by the close planting. Other apparent yield-component effects were largely limited to a lower yield in treatments C through H when compared with treatment B, which uniformly received 6-inch irrigations. Average yields of corn grain were 132 bushels per acre from the plots under moisture stress, and 142 bushels per acre from the uniformly irrigated plots (differences significant at the 10% level). The dollar savings can be easily calculated on a large tract in which only about one-tenth of the area is used for indicator strips for determining irrigations, versus the risk of lower yields over the whole area, due to improper or late irrigation. It was also apparent in this study that the 5-inch (close) plant spacing was the better of the two spacings used under the prevailing conditions and treatments, and perhaps should be considered the normal planting rate in future tests.

Corn was selected intentionally for this experiment because it is sensitive to water stress. Unlike some other crops, vegetative growth of corn and subsequent yield are very closely tied together in that they both decrease in response to water stress. Not all crops show the same temporary visual moisture-stress symptoms which result in yield losses, and this should be taken into account when this irrigation technique is considered for use on other crops.

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GRAPH 3. AVERAGE GYPSUM BLOCK READINGS, UNIFORM IRRIGATION
10-INCH PLANT SPACING, CORN—WSFS, 1972.

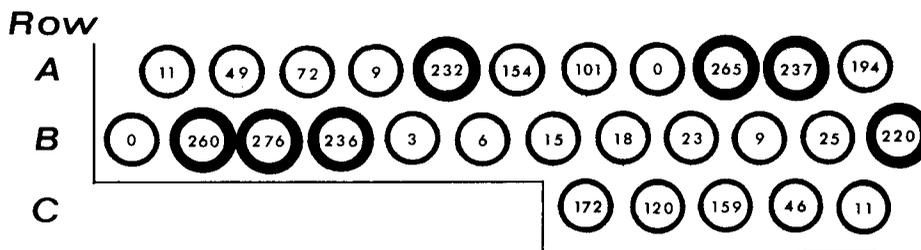


AT VISTA

Coit plantation

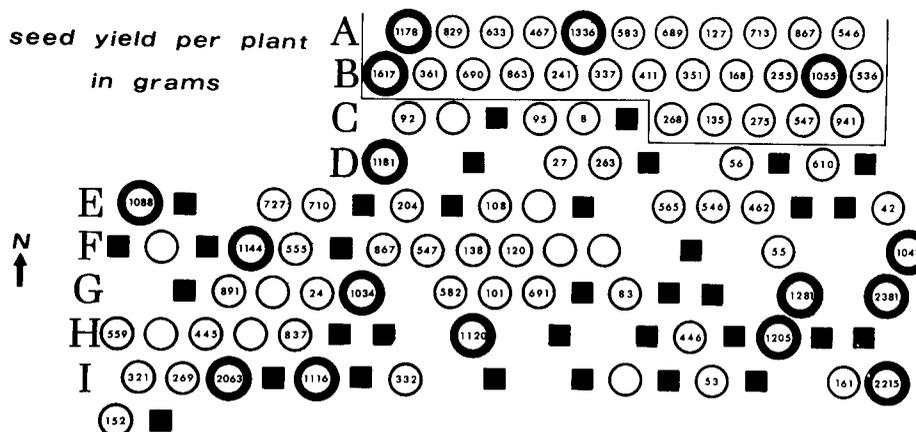
monstration plot

VISTA PLANTATION 1963. SEED YIELD PER PLANT (g)—"Vista" seedlings only.



Plot No. 1 (top) and plot No. 2 (bottom) in the Vista jojoba plantation (1972).

Vista Plantation - 1972



YIELD OF JOJOBA SHRUBS PLANTED IN 1953, COIT PLANTATION, VISTA ROWS ARE COUNTED EAST TO WEST AND THE SHRUBS NORTH TO SOUTH

Shrub location	Yield			Ave. nut weight 1959
	1957	1958	1959	
Row 1	grams per shrub			
	1	20	244	1430
	2	....	70	1750
	3	....	....	340
Row 2	3	....	....	270
Row 3	1	....	....	850

under the supervision of Dr. N. T. Mirov. Performance data from that nursery, which was abandoned in 1955, have not been published.

The Vista plantation consists of two plots. (See photos.) Plot no. 1 has five female and seven male shrubs from seed supplied by Dr. N. T. Mirov who obtained it from the Boyce Thompson Arboretum at Superior, Arizona. These seeds were planted in May, 1953 at a spacing of 6 by 6 ft. Except for an occasional hoeing of the weeds, no irrigation or other care was given to this plot. Rainfall in the five years after planting averaged 12.45 inches. One female shrub and almost all male shrubs flowered in 1957; a second female shrub flowered in 1958, but it was not until 1959 that all shrubs had blooms. That year a substantial crop of nuts was produced, as shown in the table. The harvest was from August 1 to September 6. Shrub no. 1 in Row 1 was outstanding in earliness, vigour, and yield; it was propagated by rooting cuttings and it was named variety "Vista" by Dr. Coit. Average height of shrubs in the seventh year was 33 inches for females and 40 inches for males. Now, in the nineteenth year, male and female shrubs are of about equal size and measure 7 ft in height with an average maximum diameter of 8 ft. No yield data were recorded for this plot after 1960.

Plot no. 2, to the north of plot no. 1, consisted of 86 female and 34 male seedlings in nine rows, planted in June 1959. The origins of the seedlings were:

- row A—(North end), 11 rooted cuttings of Vista
- B—(North end), 12 rooted cuttings of Vista
- C—East end, 5 cuttings of Vista. West end, 6 seedlings from the Arlington planting (contributed by P. Thomson)
- D—East end, 6 seedlings from shrub no. 2, Row 1, in Plot no. 1. West end, 6 seedlings of Vista
- E—18 seedlings contributed by Dr. H. S. Gentry, accession no. 16820 from Camp Creek, Arizona
- F—18 seedlings contributed by Dr. H. S. Gentry, accession no. 16828 from Camp Creek.
- G—18 seedlings contributed by Dr. H. S. Gentry, accession no. 16842 from San Vincente, Baja California
- H—18 seedlings contributed by Dr. H. S. Gentry, accession no. 16847 from Baja Cal.
- I—18 seedlings contributed by Dr. H. S. Gentry, accession no. 16668 from Huntington Botanic Gardens

All seedlings other than Vista, were grown from seed of superior individual shrubs selected by Thomson and Gentry. These shrubs were spaced 6 ft on 8 ft rows they were watered occasionally, and thus developed faster than those in plot No. 1. Blooming in this plot started 18 to 20 months after planting. Annual rainfall, occurring mostly during the winter, measured at the plot between 1953 and 1967, averaged 12.4 inches. Plot 2 is situated on a mild slope, however, and a considerable portion of the precipitation is lost as runoff. Anthesis (the period when the ovaries swell and the anthers shed pollen) extended from January 20 to February 10 in the Vista shrubs, from December 15 to February 15 in the Arizona shrubs, and from January 1 to March 31 in the Baja California shrubs.

Detailed yield data are available for 1963 and 1972 as shown in diagrams. Most of the female shrubs started producing some fruit in 1962, but the first measurable yields were recorded in 1963. In that year, seven of the Vista seedlings yielded 230 to 280 grams of seed per shrub, six yielded 100 to 170 grams, and 14, less than 100 grams. In 1964 with a rainfall of only 8.45 inches, the Vista shrubs averaged 53 grams of seed, while the remainder average 75 grams per shrub. In 1965 the average production of the Vista shrubs was 350 grams per



Jojoba—plot No. 1 (top) and plot No. 2 (below) at Vista.

shrub, the Arizona accessions 80 grams, and the Baja California accessions 135 grams. After harvest that year, all shrubs were heavily pruned, and, as a result, yields in the following year (1966) dropped to 10 to 70 grams per shrub. The heavy pruning may have caused lower yields in the following two to three years also.

An irrigation trial was conducted from November, 1965, to December, 1967. The 24 Vista plants were divided into three groups. Group 1 included the first four shrubs of row A and of row B, on the West end; group 2 included the next 4 shrubs of row A and of row B to the East of group 1; group 3 included the remaining 3 shrubs in row A and 4 shrubs in row B. No water was applied to group 1, 4½ gallons of water per plant were applied monthly to group 2, and 9 gallons to group 3. In 1967, group 1 yielded 142 grams of seed per plant and group 2, 145 grams, while group 3 yielded 290 grams per bush. The Arizona plants that year averaged 135 grams per shrub, and Baja California 286 grams. About 80% of the Vista seed matured between August 1 and September 30, while the seed of plants from Baja California matured between August 15 and October 10. About 50% of the Arizona seed and 70% of the Baja California seed was harvested between September 1 and 21.

No additional yield data were re-

corded in plot 2 until 1972 when the shrubs were 13 years old. In spite of the fact that rainfall in Vista between January and September, 1972, only amounted to 1.59 inches, seed yields were impressive as shown in plot diagram. The highest yield produced by a single shrub was 2,381 grams. Three shrubs exceeded 2,000 grams, 13 shrubs exceeded 1,000 grams and 61 shrubs produced less than 1,000 grams per shrub. The largest shrub was 7 ft tall and had a maximum diameter of 8 ft. Average height was 5 ft and average maximum diameter was 7 ft. Because of the low rainfall, seed maturity was advanced considerably and all seed was harvested during the first week in August.

In reviewing the overall performance of the jojoba shrubs at Vista certain points should be considered. The shrubs grew under semi-wild conditions because, except for the fact they were not browsed, very little cultural care was given to them. Furthermore, they were repeatedly set back because of pruning and because of cuttings being taken from them. Finally, although the average rainfall recorded in the period 1953–1972 was 11.3 inches only a portion of this precipitation actually benefited the shrubs because of the sloping morphology of the plot. A great deal of environmental variability was present as reflected in the yields of the Vista shrubs which were genetically identical. These

shrubs were considerably more uniform in time of anthesis and maturation than the rest of the shrubs in the nursery. Nevertheless, the range of yields of the Vista shrubs in 1972 was of about the same magnitude as the range of yields from shrubs of different genetic origin. Thus, optimizing environmental factors in the nursery would seem to be far more important than selecting genetically superior types. The distribution pattern of male shrubs in the nursery—though uneven and conceivably a cause of variability in seed setting—does not appear to have contributed to any detectable seed yield pattern.

If commercial plantations of jojoba were to be established, suitable locations could be selected so as to minimize variability and limitations in production due to environmental factors. For this reason, the maximum yields obtained in Vista are more informative about the potential of jojoba than the low ones. Maximum yields realized in Vista are 1,760 grams for a 6-year old shrub and 2,381 grams for a 12-year-old shrub. It would be reasonable to expect still higher yields in new plantations with improved cultural practices after selection of better genetic materials. Further yield increments would accrue as shrubs grow older. In the Huntington Botanical Gardens at San Martino, California, yields of 15 kg were recorded from 22- to 25-year-old shrubs.

On the basis of plant development at Vista it would seem desirable to plant jojoba 4 to 5 ft apart on 10 ft rows and with a six-female to one male shrub ratio, so as to have about 750 producing plants per acre. After the twelfth year, thinning of shrubs on the row to a lower population density might be desirable. Basing yield predictions on the best yields of the Vista plantation, a yield of 3,300 kg/hectar (2910 lbs/A) for a 6-year-old plantation and 4464 kg/hectar (3,930 lbs/A) for a 12-year-old plantation could be possible. These yields cannot be accepted with the same confidence as yields measured in properly designed and replicated trials. Nevertheless, they are the only yield data available in California from cultivated jojoba.

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