

Salt Damage to Strawberries

types of water, irrigation system, and soil condition found to influence salt accumulation in strawberry plantings

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Cultural practices necessary for strawberry production cause salt accumulation—with resulting injury to the plants—in some areas where the irrigation water is generally considered of good quality for most crops.

When strawberries grown on raised beds are irrigated by furrows between the beds, the water reaches the surface of the beds only by lateral and upward movement. Solar evaporation and plant transpiration remove the water, and the salts carried in by the water remain in the surface soil of the bed. In the summer, there is practically no downward water movement through the surface 6" of the bed to carry out the deposited salts. Because the young strawberry plant is comparatively shallow-rooted, frequent irrigations are necessary, and with each irrigation more salt is deposited until plant growth is retarded or, in extreme cases, the plant is killed. Maximum salt accumulation occurs in the surface 2" of the bed where the salt concentration ranges from 2-to-25 times the concentration in the 2"-to-6" depth. Thus, the damage resulting from the salt accumulation is dependent upon the age and root depth of the plant.

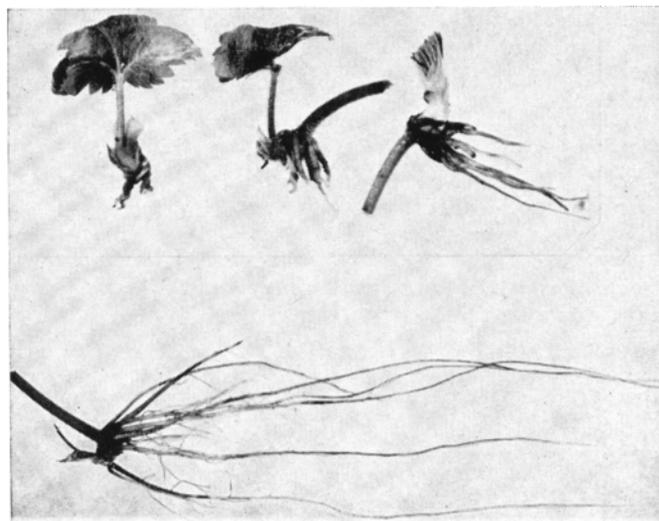
In young plantings, the first evidence of injury is a lack of vigor, retardation of growth, and higher plant mortality. The most affected plants will show an edge-burn of leaves, and when the accumulation is high enough, these plants die. In general, fewer roots develop from the base of the plants. These roots tend to be thick. There is a lack of fine root development. The runners from these plants seldom develop normal roots unless buried below the surface 2". Roots of runners which do develop in the sur-

face layer are short and thickened with practically no fine root formation.

In the second year, plants which have not been visibly affected in the first year and have attained normal size as well as deeper root development will apparently stand a higher degree of salt and may show evidence of salt accumulation only by a general lack of vigor. As the season advances and salt accumulation increases, the symptoms of salt damage are severe edge-burning. With a further increasing salt concentration, the scorching extends back into the plant until the plant is killed.

To prevent salt accumulation, the basic problem is to induce sufficient downward movement of water through the surface of the bed to leach out the salts left by the previous irrigation. If the soil of the planting is sufficiently permeable to water, this can be accomplished by using an overhead sprinkler system for irrigation.

In 1952, experimental plots were established at Torrey Pines and Fallbrook



Upper row: clublike, thickened roots of runner plants caused by excess salt in the surface of the bed. Plants with these roots will grow only as long as they are nourished by the mother plants. Bottom row: roots of a normal runner plant grown in good soil.

in San Diego County to study salt accumulation and its effect upon strawberry plant growth and yield.

On each site, comparable furrow and sprinkler irrigated plots were set up. The soils of the plots—Carlsbad and Fallbrook soil series—are readily permeable to water and at the beginning of the experiment contained very little sodium or chloride salts. In each case, the water applied contained some sodium or chloride, although it would still be classified as good water.

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Water, Soil, and Yield Data for the 1952 Fallbrook and Torrey Pine Plots

	Total Na + Cl in irrigation water	Soil treatment	Method of irrigation*	1953 Harvest		1954 Harvest		
				Av. m.e. Na + Cl in surface 6"	Yield crates	Av. m.e. Na + Cl in surface 6"	Yield crates	
				ppm	maximum	per acre	maximum	per acre
Fallbrook 1953	172	Check	S	3.0	3400	7.0	950	
				F	8.0	2450	14.0	580
			Sulfur added	S	4.0	1960	6.0	770
				F	8.0	1150	15.0	960
Torrey Pines 1952	96	Check	S	1.2	4760	4.0	2525	
				F	5.0	4245	12.0	2714
			Sulfur added	S	1.5	4860	5.0	2875
				F	7.0	3780	12.0	2960

1953 Plantings, San Luis Rey and Torrey Pines

	Total Na + Cl in irrigation water	Soil treatment	Method of irrigation*	First Harvest	
				Av. m.e. Na + Cl in surface 6"	Yield crates
				ppm	Maximum
S. L. R. 1953	245	Check	S	8.0	2345
				F	22.0
T. P. 1953	96	Check	S	9.0	3580
				F	11.0

* S—Sprinkler. F—Furrow.

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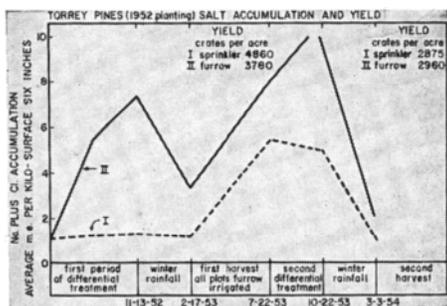
STRAWBERRIES

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Four plots were established at Torrey Pines and at Fallbrook: 1. A sprinkler irrigated plot to which no soil amendment treatment was applied and 2, a comparable furrow irrigated plot. 3. A sprinkler irrigated plot to which a top application of sulfur at the rate of one ton per acre was applied and 4, a comparable furrow irrigated plot. Comparable plots were treated with equal amounts of ammonium sulfate whenever necessary to maintain an adequate nitrogen level.

The plots were planted to the Lassen variety during April 1952. All plots were sprinkler irrigated until late June to insure a uniform start. Then differential irrigation treatments were begun.

Periodically the plots were soil sampled through two harvests. As shown in the graph on this page, there was no appreciable change in the salt content of the sprinkler irrigated plot at Torrey Pines until the beginning of the first



Above graph shows how salt accumulated during a two-year period on comparable sprinkler and furrow irrigated strawberry plots at Torrey Pines.

harvest. However, there was a continuous accumulation of salt in the furrow irrigated plot until the fall rains began to leach the salts from the soil.

At the beginning of the first harvest there was no visible difference in the appearance of the plants in the two irrigation treatments, but the sprinkler irrigated plot produced about 28% more berries. It appears that while the higher salt accumulation in the furrow irrigated plot did not visibly affect the appearance of the plants, it did affect root growth, vigor, and possibly food storage reserves to the extent that the yield of berries was reduced.

Sprinklers could not be used during the four months period of the first harvest—because of the danger of fruit loss from mold and rot—so all plots were furrow irrigated until differential treatments could be resumed. Consequently, the second-year salt accumulation curves of the two plots shown in the graph are quite different from those of the first year. The salt content of the sprinkler

irrigated plot rose continuously during the second year until the harvest was over and sprinkling could be resumed. Then the salt content remained at a level five times that of the first year, until the winter rain period.

In the furrow irrigated plot, the salt content increased continuously until winter to reach a maximum about 50% higher than the first season.

The differences in the salt content of the sprinkler and the furrow irrigated plots in 1953 apparently were not sufficient to materially affect the 1954 harvest.

As shown in the larger table on page 11, the plots at Fallbrook behaved similarly to those at Torrey Pines.

The average first harvest yield of the sprinkled plots was 48% higher than that of the furrow irrigated plots.

San Luis Rey Test

Because there were no visible differences during the first season between the appearance of the plants under sprinkler and furrow irrigation in the 1952 plantings, another experimental planting was started in 1953 in the San Luis Rey area. Visible salt accumulation injury commonly occurs in commercial plantings in that area, and the irrigation water contains considerably more sodium and chloride salts. The soil is a loamy sand type. At the beginning of the test, this soil contained very little chloride and sodium salts—about the same amount as the Fallbrook and Torrey Pines soils.

The San Luis Rey plots were managed in nearly the same manner as the previous plots. The Lassen variety was planted in April, and all plots were sprinkled to insure a good start before differential treatments were begun. Because of the poorer quality of the irrigation water used, the salt content of the surface 6" of soil in the sprinkler irrigated plot rose to about the same level as that of the furrow irrigated plots of the Fallbrook 1952 plantings. The size

Strawberry plants in the process of being destroyed by extreme salt accumulation conditions. The sharp change in color—A—is the point where salt accumulation begins.



and vigor of the plants, however, were not visibly affected. In the case of the comparable furrow irrigated plot there was a considerable accumulation of salt, the maximum being about 2½ times that of the sprinkler irrigated plots. The plants in the furrow irrigated plots were slightly smaller and less vigorous than those of the sprinkled plot. The first harvest yield of the sprinkler irrigated plot was 18% higher than that of the furrow irrigated plot. Probably the original low levels of salts in the soil could not be maintained by sprinkling because of water quality. However, under furrow irrigation the salt content did rise to much higher levels and the difference in salt levels brought about the differences of yield.

Torrey Pines Test

Another planting was also started at Torrey Pines in 1953 and was managed in essentially the same way as the 1952 planting. Virgin land was cleared of underbrush, and the leveling necessary to prepare the plots may have affected the character of the soil which—at planting time—contained very little sodium or chloride. In this test, the use of the sprinkler system did not retard salt accumulation which was nearly as high in the sprinkled plot as in the furrow irrigated plot. There was no visible salt injury to the plants in either plot. There was no appreciable difference in the first harvest yield of the two plots.

Results of the tests indicate that when irrigation water containing more than 100 ppm—parts per million—of sodium plus chloride is used to irrigate strawberries by the furrow system, there can be sufficient salt accumulation to produce a measurable decrease in the first harvest yield of berries although the plants themselves do not show visible signs of injury. On soils sufficiently permeable to water, changing from a furrow system to a sprinkler system of irrigation may effectively reduce salt accumulation so that higher first harvest yields are obtained.

Sprinklers are much less effective in holding down salt accumulation during the second year because there is considerable salt accumulation while the first crop is being harvested, when it is not practical to use the sprinkler system.

With the types of irrigation water and the soil conditions in the tests, salt accumulation will probably be less under sprinkler irrigation than under furrow irrigation. However, it is difficult to secure adequate amounts and distribution of water with sprinklers, so it is necessary that the system be carefully planned.

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