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Irrigation Water Quality Options for Corn on Saline, Organic Soils *

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Summary. Corn production on the organic soils of the Sacramento–San Joaquin Delta of California was affected by the salinity of the irrigation water and the adequacy of salt leaching. Full production was achieved on soils that were saline the previous year, provided the electrical conductivity of the irrigation water (EC_i) applied by sprinkling was less than about 2 dS/m and leaching was adequate from either winter rainfall or irrigation to reduce soil salinity (EC_{sw}) below the salt tolerance threshold for corn (3.7 dS/m). For subirrigation, an EC_i up to 1.5 dS/m did not decrease yield if leaching had reduced EC_{sw} below the threshold. If leaching was not adequate, even nonsaline water did not permit full production. In agreement with previous results obtained in a greenhouse, surface irrigation with water of an electrical conductivity of up to 6 dS/m after mid-season (end of July) did not reduce yield below that of treatments where the salinity of the irrigation water was not increased at mid-season. Results also reconfirm the salt tolerance relationship established in the previous three years of the field trial. The earlier conclusion that the irrigation method (sprinkler or subirrigation) does not influence the salt tolerance relationship was also confirmed.

At the conclusion of a 3-year field study to determine the salt tolerance of corn in the organic soils of the Sacramento–San Joaquin Delta of California (Hoffman et al. 1983), soil salinity levels in some treatments, where saline irrigation waters had been applied, were high enough to cause significant reductions in corn yield. The salinity levels were considerably higher than would be expected with typical irrigation practices in the Delta but might be present at the end of a severe drought or following periods of inadequate leaching. The presence of these field conditions prompted an additional season of study at the same experimental site during 1982.

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The primary objective was to determine if full corn production could be achieved with irrigation water salinity in excess of the present water quality standard[1] for the Delta (electrical conductivity of 0.45 dS/m) even though soil salinity at the end of the 1981 growing season in some treatments was in excess of the salt tolerance threshold for corn (average electrical conductivity of soil water of 3.7 dS/m, Hoffman et al. (1983)). Another objective was to test under field conditions, the results of Maas et al. (1983) which indicated for greenhouse conditions that corn can tolerate high levels of soil salinity late in the season without yield reduction.

Experimental Procedure

The experimental design was similar to that reported by Hoffman et al. (1983). Only pertinent details and changes in experimental design and procedure are presented here. Many of the treatments in this experiment, however, are drastically different from those of the previous study. In keeping with the objective, the electrical conductivity of the irrigation waters (EC_i's) were considerably lower in 1982 than in 1981 for many treatments. In some treatments EC_i was increased at mid-season to determine if increased salinity late in the season would reduce yield. For comparisons with results from previous years a few treatments were maintained at the same level as in the previous study.

The 30 sprinkled plots (see Fig. 1) were divided into ten treatments with three replicates. Water was applied by mini-sprinklers which had a wetted diameter of about 4 m, spaced 1.5 m apart along each lateral located in every other corn row. The average application rate was a depth of 16 mm/h. To provide easy reference, a treatment code and accompanying symbols for data points were adopted for each treatment. The code indicates the EC_i for 1982 and 1981. For example, treatment 1/8 had an EC_i of 1 dS/m throughout 1982 and 8 dS/m throughout 1981. For brevity, the control treatment ($EC_i = 0.2$ dS/m) is noted as 0. In other treatments, EC_i was increased on July 22, 1982 and remained at the higher salinity level for the remainder of the irrigation season. As an example, EC_i was increased from 2 to 6 dS/m in one treatment after having been irrigated with water having an EC_i of 2 dS/m in 1981. The code for this treatment is 2–6/2. Treatments where EC_i remained the same in 1982 as in 1981 are 0/0, 2/2, 4/4, and 6/6. Treatments where EC_i was lower in 1982 than in 1981 are 0/8, 1/6, and 1/8. Treatments where EC_i was increased in July are 0–4/0, 2–6/2, and 4–6/4. The letters in Fig. 1 identify different replicates.

As in the previous study, each subirrigation plot was irrigated by filling two ditches, each approximately 15 cm wide by 60 cm deep, spaced 16 rows of corn apart. The code for the subirrigated treatments was similar to that for the sprinkled plots. As will be discussed later, the two sets of control treatments (I and II) are treated separately. Thus, the subirrigated treatments are I0/0, II0/0, 0.7/2, 0.7/6, 1.5/2, 1.5/4, 6/4, and 6/6.

Suction cups and tensiometers were installed at soil depths of 30, 45, 60, and 90 cm. Soil solution was extracted by vacuum through the suction cups beginning the second week in June. Solution extracts were obtained weekly until the third week of September. Solutions could not always be extracted, particularly from cups shallow in the profile. Four-electrode salinity probes (Rhoades 1979) were installed at depths of 30, 60, and 90 cm. Each of the instruments, suction cups, tensiometers, and salinity probes, was placed 30 cm apart in the corn row adjacent to the harvest area as in the previous study. An access tube was installed in the row and 30 cm from the nearest instrument to measure water content with a neutron probe. The depth of the water table below the soil surface was monitored in 1982 with nine observation wells in the subirrigated plots and six in the sprinkled plots. In addition to the main surface drain to the east, open drains were provided as before on the south and west side of the experiment.

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[1] Water Right Decision 1485, California State Water Resources Control Board, August, 1978

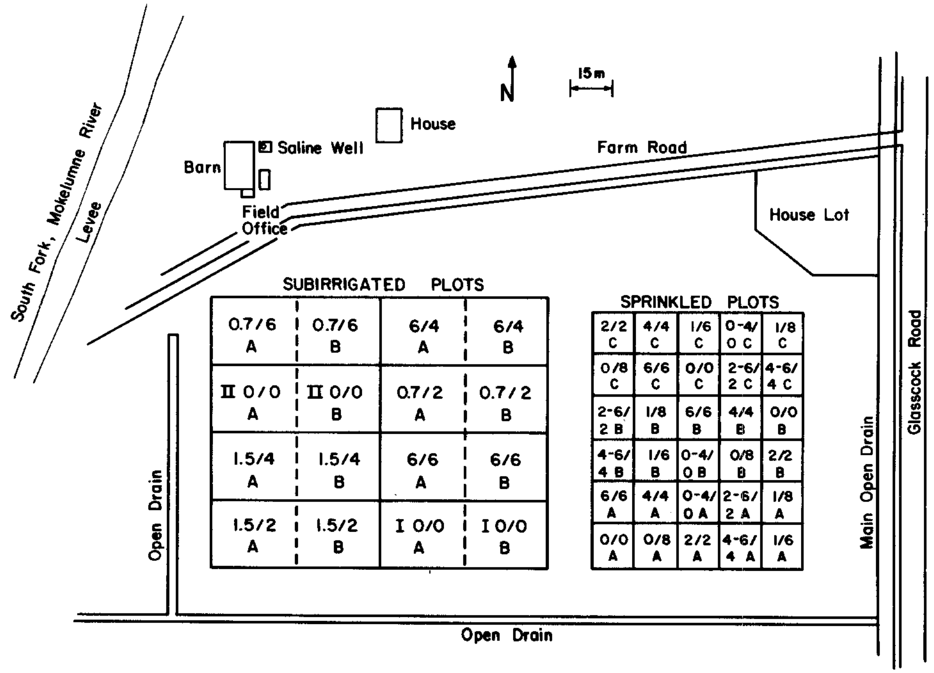

Fig. 1. Experimental design for the field trial in 1982

Soil samples were taken at 15-cm depth intervals from the soil surface to a depth of 90 cm. Samples were taken on June 1–2, July 15–19, and September 22–29 in both sets of plots. In the subirrigated plots, samples were also taken on August 16–19. Soil samples were taken to provide salinity data shallow in the soil profile and augment the values obtained from the other methods deeper in the profile. To make the measurements of the electrical conductivity of the saturated-soil extracts (EC_e) comparable to the other measures, the values of EC_e were corrected for soil water content by the relationship $EC_{sw} = EC_e \theta_e / \theta_{sw}$, where θ is the volumetric soil water content and the subscripts sw and e indicate soil water and saturated extract values, respectively.

The corn (*Zea mays* L. cv. Dekalb XL75) was planted on May 12, two weeks later than in 1980 and 1981 because of the cool, wet spring. The basic agronomic practices were the same as in the previous study. The herbicide, Lasso[2], was applied at the rate of 4.5 kg/ha before planting the corn and incorporated to a shallow soil depth. Herbicides, Atrazine[2] (2.2 kg/ha), Basagran[2] (1.1 kg/ha), and oil (8 l/ha) were applied the third week of May and the first week of June to all plots and again the second week of June in the sprinkled plots.

Plant height was measured in all plots on September 3 after the plants had reached their maximum height. Height was measured from the soil surface to the top of the tassel. The corn was harvested the week of October 18. The harvest procedure was the same as in previous years. The average mass of a kernel was determined on three subsamples, each containing 200 kernels from each plot.

As in previous years, the sprinkled plots were irrigated at twice the amount of the estimated evapotranspiration. Because of the wet winter and cool spring, sprinkling did not begin until June 21, after which it was conducted on a weekly basis. For the same reason, the subirrigated plots were irrigated only twice; the same frequency used by most farmers in the area. The first subirrigation began on July 13 and lasted 52 h; the second began on August 16 and required 66 h.

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[2] Mention of trade names does not imply any endorsement by USDA/ARS

Results and Discussion

Water Balance

The average amounts of water applied each month to the sprinkled and subirrigated treatments are summarized in Table 1 along with estimated evapotranspiration for the control treatment, pan evaporation, and rainfall. The values are presented as depth of water (mm) assumed to be distributed uniformly over the entire area of each plot. The same total amount of water (1,110 mm) was applied to each sprinkled treatment during the season. The total amounts of water applied to the subirrigated treatments are also given in Table 1. The net application to the subirrigated treatments is the difference between the total application and the amount leaving the irrigation ditches and not entering the soil profile. The average seasonal net application was 770 mm from a total application of 1,550 mm (Table 1).

Evapotranspiration (ET) for the control (nonsaline) treatment, calculated from $ET = k_c E_p$ where k_c is the crop coefficient and E_p is pan evaporation, was 587 mm (Table 1), about the same as the 600 mm in 1979 and the 580 mm in 1980, but less than the 690 mm for 1981. Rainfall during the 1982 growing season was minimal (55 mm). The average volumetric soil water content in the 900 mm-deep root zone at the end of the irrigation season (58%) was essentially the same as at the beginning of the season (56%) in the sprinkled treatments. If rainfall and changes in soil water storage during the growing season are ignored, drainage from the sprinkled control treatment (0/0) was 523 mm (1,110–587). The resultant leaching fraction (L) is 0.47 ($L = 523/1{,}110$). Including rainfall during the growing season and the change in soil water storage in the root zone, L becomes 0.43 ($L = [523-(0.58-0.56)900]/[1{,}110+55]$). For the subirrigated treatments, soil water content decreased 5% (56% at the beginning versus 51% at the end of the irrigation season). The equivalent of 45 mm was removed from soil storage in the root zone. If ET was the same as for the sprinkled control treatment (587 mm), drainage was 228 mm (770–587 + 45) for the control subirrigated treatment and the leaching fraction was 0.28 (228/770 + 55).

Volumetric soil water contents (θ) at four soil depths throughout the season for both sprinkled and subirrigated treatments are illustrated in Fig. 2. At the 90-cm depth for both irrigation methods, θ remained stable with values between 0.75 and 0.85 because of the proximity to the water table and the shallow corn root zone.

Table 1. Pan evaporation, rainfall, estimated evapotranspiration for the control treatments, and irrigation application for the sprinkled and subirrigated treatments; all data are in mm

	May	June	July	Aug.	Sept.	Total
Pan evaporation	209	209	203	218	151	989
Evapotranspiration	30	72	181	197	107	587
Sprinkler application	0	174	334	532	70	1,110
Subsurface irrigation						
Total applied	–	–	1,170	380	–	1,550
Net applied	–	–	390	380	–	770
Rainfall	0	0	8	0	47	55

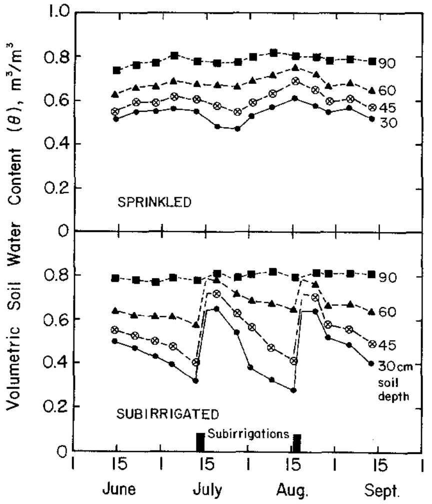

Fig. 2. Volumetric soil water content as a function of soil depth for both the sprinkled and subirrigated treatments

For the sprinkled treatments, θ was relatively constant during the season at all soil depths. The slight drop in late July, particularly at the 30-cm depth, was caused by the interruption in sprinkler irrigation during the first subirrigation. For the subirrigated treatments, θ dropped below 0.4 at the 30-cm depth in response to plant water extraction just prior to each subirrigation. The rapid replenishment of soil water following each subirrigation is obvious to a depth of 60 cm. Differences in soil water content between salinity treatments were not significant and thus only average values are reported.

The water table was below a depth of 90 cm for the sprinkled treatments except at the beginning of the irrigation season and one brief period in mid-August. At the end of the irrigation season the water table was below 1.2 m. The water table in the subirrigated treatments was below a depth of 1.0 m except for about a 2-week period during and after each subirrigation.

Soil Salinity

Three methods were used to determine soil salinity; electrical conductivity measurements of soil water extracted by suction cups, readings from four-electrode salinity probes, and the electrical conductivity of soil water converted from electrical conductivity measurements of saturated extracts from soil samples by the ratio of field to saturated volumetric water contents.

The change in the electrical conductivity of the soil water (EC_{sw}) extracted from the suction cups during the season is illustrated in Fig. 3 for both the sprinkled and subirrigated treatments. Data for all four depths monitored are averaged so the average root zone salinity could be illustrated. For ease in comparison, the salinity treatments in the sprinkled plots were divided into three groups: (1) those where the salinity of the irrigation water (EC_i) was lower in 1982 than in 1981 (reduced salinity treatments); (2) those where EC_i was increased midway through the 1982 season (increased salinity treatments), and (3) those where EC_i in 1982 remained the same as in 1981 (constant salinity treatments).

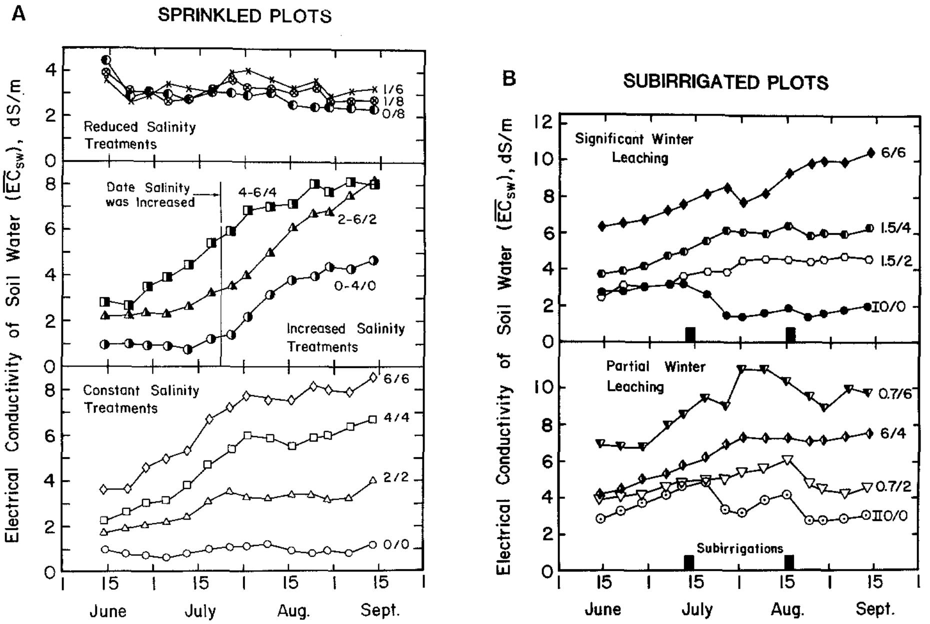

Fig. 3 A, B. Time courses of the average electrical conductivity of soil water extracted with suction cups in the root zone of all salinity treatments in the sprinkled plots (**A**) and in the subirrigated plots (**B**)

Salts were leached from the upper portion of the soil profile because of the large amount of rainfall (635 mm) during the winter 1981/82. Thus soil salinity tended to increase during the season in the saline treatments in response to the saline irrigation water. As expected, the rate of salination increased midway through the season for those treatments where EC_i was increased beginning on July 22. Note that treatment 2–6/2 reached the same final soil salinity as treatment 4–6/4. Although winter rainfall was above normal and leaching was significant, applying water with an EC_i of 0.2 or 1 dS/m continued to reclaim the saline soil profile during the season for treatments 0/8, 1/8, and 1/6. Leaching from winter rainfall was sufficient to reduce soil salinity below the salt tolerance threshold of corn (3.7 dS/m) for all the sprinkled treatments except the plots that received irrigation water of either 6 or 8 dS/m the previous year (Fig. 3).

The subirrigated treatments were divided into those receiving “significant” or “partial” leaching prior to planting. In addition to winter rainfall, 125 mm of nonsaline ($EC_i = 0.2$ dS/m) water was applied by sprinking to all subirrigated plots before planting. The difference in soil salinity between the I0/0 (significant leaching) and II0/0 (partial leaching) treatments (Fig. 4) was caused by differences in winter leaching, due to differences in the distance of the plots from the open drain at the south edge of the experiment and lateral movement of salinity from the 6 dS/m plots to the north of the II0/0 plots during the winter. Suffering a similar fate during the winter was treatment 0.7/2 where salinity moved laterally from the 4 dS/m plots. Leaching differences between the two subirrigated treatments that

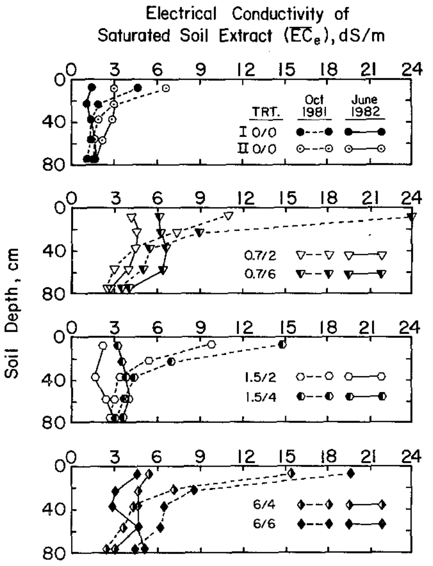

Fig. 4. Soil salinity profiles measured from soil samples at the end of the 1981 cropping season (October) and at the beginning of the 1982 irrigation season (June) for the subirrigated treatments

received irrigation water having an EC_i of 2 dS/m during 1981 are also illustrated in Fig. 4.

Leaching in treatment 0.7/2 during the winter was not as complete as expected when compared to winter leaching for treatment 1.5/2. Note in Fig. 3 that subirrigations reduced the average EC_{sw} for the root zone after both subirrigations for treatments II0/0 and 0.7/6; after the first subirrigation for I0/0, and only after the second subirrigation for 0.7/2.

As an estimate of the average soil salinity within the root zone for corn (0–90 cm), the salinity values over time and with soil depth were averaged for each measuring technique and are presented in Table 2. As in the previous study (Hoffman et al. 1983), the agreement among the three measures of salinity is reassuring. Because the same soil depths were not monitored by all three methods, average values were determined for depths of 15, 30, 45, 60, 75, and 90 cm by considering the time-averaging mean values from the three methods made directly above or below these six depths. The salinity values for the six soil depths were then averaged to give the composite value for the root zone given in Table 2 for each treatment. In Fig. 3, only the subirrigated treatments of I0/0 and 1.5/2 dS/m remained below the salt tolerance threshold for corn (3/7 dS/m) early in the season. Winter leaching, as discussed below, was not adequate to reduce soil salinity below the threshold in the other treatments.

The primary objective of the field trial in 1982 was to determine if full crop production could be achieved with a water quality in excess of the present standard even though soil salinity at the end of the 1981 growing season was in excess of the salt tolerance threshold. Unfortunately for the experiment, rainfall during the 1981–82 winter (635 mm) was well above normal (400 mm). No provisions were made for leaching during the winter. In fact, the ditches for subirrigation and the drainage ditch on the west side of the experiment were filled. The drainage ditch on

Table 2. The mean electrical conductivities of the soil water in the root zone ($\overline{EC}_{sw}$) for each salinity treatment as determined by three measuring techniques. The composite values are depth-averages of the various measurements. All data are in dS/m

	Sprinkled treatments									
	0/0	0/8	0–4/0	1/6	1/8	2/2	2–6/2	4/4	4–6/4	6/6
Suction cups	1.0	3.2	2.1	3.4	3.2	2.6	4.0	4.2	5.1	5.9
Salinity probes	1.5	2.9	3.1	2.5	3.3	2.8	4.4	4.6	4.9	5.3
Soil samples	1.5	3.1	2.5	3.0	3.8	2.9	4.2	4.4	4.9	6.1
Composite	1.2	3.1	2.4	2.9	3.4	2.8	4.1	4.4	4.9	5.8

	Subirrigated treatments							
	I0/0	II0/0	0.7/2	0.7/6	1.5/2	1.5/4	6/4	6/6
Suction cups	2.3	3.4	4.5	8.5	3.6	5.1	5.8	7.9
Salinity probes	2.5	–	4.1	4.0	2.2	4.9	6.3	4.6
Soil samples	2.5	4.6	6.4	9.6	4.9	6.7	7.4	8.0
Composite	2.4	4.1	4.9	7.2	3.5	5.5	6.4	6.9

Table 3. Total amount of salt[a] in the soil profile (0 to 90 cm depth) based on soil samples (EC_e) before and after the winter rains of 1981–82 as a function of distance from the drainage ditch

Distance from ditch m	Salinity treatment	Root zone salinity (kg)		Salinity reduction %
		Oct. 1981	June 1982	
25	I0/0	630	540	14
	1.5/2	1,510	890	41
50	1.5/4	1,950	1,310	33
	6/6	2,720	1,570	42
75	II0/0	800	810	0
	0.7/2	1,680	1,300	23
100	6/4	1,890	1,460	23
	0.7/6	2,700	1,930	29

[a] Amount of salt was calculated from EC_e measurements by assuming 640 g of salt per m^3 of soil solution equals 1 dS/m and $EC_e \theta_e = EC_{sw} \theta$

the south side of the experiment remained open and the water in the ditch was automatically pumped into the main drainage channel that passes the experimental site on its eastern boundary. Thus, drainage was only provided on the south side of the subirrigated plots.

For soil water to move into the drainage ditch from the subirrigated treatments it had to move laterally 25 m from the center of the I0/0 and 1.5/2 plots, a distance of 50 m for the 1.5/4 and 6/6 plots, 75 m for the II0/0 and 0/7/2 plots, and 100 m for the 0.7/6 and 6/4 plots. The degree of leaching achieved and the soil salinity distributions before and after the winter rains can be seen in Fig. 4. These salinity

Table 4. Grain yield, total shoot biomass, mean kernel mass (all adjusted to a water content of 15.5%) and maximum plant height as a function of the salinity treatment and the irrigation method for corn grown in the Sacramento–San Joaquin Delta. LSD denotes least significant difference at the 5% level of probability

	Sprinkled treatments										
	0/0	0/8	0–4/0	1/6	1/8	2/2	2–6/2	4/4	4–6/4	6/6	LSD
Grain yield (kg/m^2)	1.39	1.31	1.40	1.30	1.28	1.29	1.23	1.24	1.23	1.17	0.18
Total shoot biomass (kg/m^2)	2.83	2.55	2.76	2.48	2.52	2.62	2.52	2.57	2.46	2.44	0.36
Mean kernel mass (mg)	343	337	336	341	336	324	312	338	309	308	26
Plant height (cm)	356	345	358	345	344	354	353	345	351	329	22

	Subirrigated treatments								
	I0/0	II0/0	0.7/2	0.7/6	1.5/2	1.5/4	6/4	6/6	LSD
Grain yield (kg/m^2)	1.27	1.05	0.89	0.80	1.32	0.94	0.66	0.77	0.15
Total shoot biomass (kg/m^2)	2.67	2.19	1.76	1.60	2.47	1.86	1.28	1.54	0.58
Mean kernel mass (mg)	324	296	278	250	302	280	209	244	47
Plant height (cm)	345	338	292	292	345	310	274	300	–

measurements were converted to the mass of salt present in the soil profile (0 to 90 cm depth) and the values before and after the winter rains are given in Table 3.

Soil salinity was reduced by about 40% for treatments where the center of the plot was within 50 m of the drainage ditch. The one exception, I0/0, had little salt to leach. Treatments beyond 50 m from the ditch had salinity reductions of about one-fourth. Salinity ($\overline{EC}_e$) at a distance of 100 m from the drain was 1 dS/m higher than that at a distance of 50 m.

Plant Response

Grain yield, total shoot biomass, and mean kernel mass are given in Table 4 for each salinity treatment. All the values are corrected to a reference water content of 15.5%.

The grain yield for the nonsaline, sprinkled treatment was 4% higher than in 1981, the most productive year of the previous experiment (Hoffman et al. 1983). Because of the increased number of treatments with a consequential reduction in replications (6 replications in previous years compared to 3 in 1982), the least significant difference for grain yield among treatments was about double that of 1981 (0.18 in 1982 vs. 0.10 in 1981 for sprinkled, and 0.15 in 1982 vs. 0.06 in 1981 for subirrigated). Thus, a statistically significant reduction for grain yield in the sprinkled plots did not occur except in the 6/6 salinity treatment nor for total shoot biomass except in the 4–6/4 and 6/6 treatments. Kernel mass was reduced significantly as salinity increased in several of the sprinkled treatments. Treatments that were high in soil salinity during 1981 but low in 1982 (0/8, 1/6, and 1/8) gave yields comparable to the control treatment. This indicates that with adequate rainfall and sufficient drainage, full corn production can be achieved with previously saline, organic soils if the salinity of the irrigation water is less than about 2 dS/m. Those treatments where EC_i was increased at midseason (0–4/0, 2–6/2, and 4–6/4) gave the same yields as companion treatments where EC_i was not increased. This verifies the greenhouse results of Maas et al. (1983) that corn can tolerate increased values of EC_i late in the season without suffering further yield reductions.

In the subirrigated treatments the two sets of control treatments (I0/0 and II0/0) gave significantly different grain yields. As discussed above, this was caused by differences in leaching during the previous winter, resulting in differences in the average salinity levels in the root zone. Except for two low salinity treatments (I0/0 and 1.5/2), yields were lower in the subirrigated treatments than those sprinkled. We believe this was caused by the inadequate leaching of some subirrigated plots by winter rainfall. This indicates that if soil salinity is not below the salt tolerance threshold for corn (3.7 dS/m) at the beginning of the irrigation season, even applying nonsaline water by subirrigation will result in yield loss. If soil salinity is below the threshold then the electrical conductivity of applied water by subirrigation may be as high as 1.5 dS/m. Except for treatment 1.5/2, the salinity treatments in the subirrigated plots caused significant reductions in kernel mass and total shoot biomass.

To place all the yield data on a comparable base, relative yield is plotted as a function of the average EC_{sw} for the soil profile (0–90 cm) in Fig. 5. The data points are grain yields for this experiment, the dashed line is the nonlinear least-squares regression (van Genuchten and Hoffman 1984) for these data, and the solid line is the salt tolerance relationship established for corn from the data obtained in 1979, 1980, and 1981 (Hoffman et al. 1983). A statistical validation test of the salt

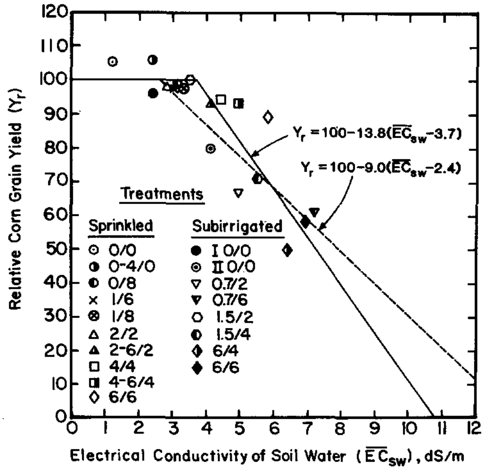

Fig. 5. Corn grain yield as a function of the average soil salinity of the root zone for the various treatments during 1982. The *dashed line* is the nonlinear least squares regression for these data. The *solid line* is the salt tolerance curve based on the results from the field trial from 1979 to 1981 (Hoffman et al. 1983)

tolerance equation ($Y_r = 100-13.8\ (\overline{EC}_{sw}-3.7)$) with the 1982 data gives a standard error of the estimate of only 8% with a 95% confidence limit. If the threshold is set at 3.7 dS/m, the statistically-fit test curve (van Genuchten and Hoffman 1984) for the 1982 data is almost identical to the salt tolerance curve. The agreement between the salt tolerance curve obtained from the earlier data and the 1982 data reaffirms that plotting relative grain yield as a function of soil salinity minimizes the influence of the irrigation method. The agreement also demonstrates that the various treatments tested in 1982 responded in a similar manner as the treatments established to construct the salt tolerance curve. As with yield, total shoot biomass of all the treatments can be placed on a relative basis for comparison. The relationships between relative shoot biomass and salinity for this and the previous experiment are almost identical.

Plant population density and the number of mature ears were slightly lower in the sprinkled than in the subirrigated plots (data not reported) even though grain yields were higher in the sprinkled treatments. Plant population density and number of mature ears in the nonsaline subirrigated plots were the same as in 1981 while both parameters were lower in the sprinkled plots. Thus, the increased yield in 1982 was caused by increased ear size, not number of ears. The highest salinity treatments had the same number of plants and ears as the control treatments for both irrigation methods. The number of nubbins was very low in all treatments.

Full corn production was achieved on the organic soils of the Delta that were saline the previous year provided the electrical conductivity of the irrigation water applied by sprinkling was below about 2 dS/m and leaching was adequate from either winter rainfall or irrigation to reduce soil salinity below the salt tolerance threshold of 3.7 dS/m for corn. Only partial leaching was achieved in most of the subirrigated treatments which reduced the salinity level of the irrigation water that could be applied without yield loss. Results indicate that if soil salinity, expressed as the electrical conductivity of soil water, exceeds the threshold at the beginning of the irrigation season, grain yield reductions can occur for irrigation water having an EC_i as low as 0.2 dS/m. If salinity is leached below the threshold then an EC_i of up to 1.5 dS/m can be applied by subirrigation without yield loss. Sprinkler application of water with an electrical conductivity of up to 6 dS/m after midseason (end of July) did not reduce yield beyond that of treatments where the salinity of the irrigation water was not increased. Results confirm the salt tolerance relationship established in the previous three years of the field trial and also confirm that the irrigation method does not influence the salt tolerance relationship.

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