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WATER AND SOIL SALINITY STUDIES ON CALIFORNIA RICE

1993 - 1995

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SUMMARY

A water and soil salinity survey was conducted (1993-95) on the westside of the Sacramento Valley to assess salinity problems on rice (Oryza sativa, L.). Each year in June, July, and August, soil and/or water samples were collected from **13 water sources** and the inlet, top and bottom basins of 27 rice fields. Yield samples were also collected. Another survey studied rice seedlings and salinity. The Electrical Conductivity (EC) of most water sources was below 0.7 dS/m, which does not pose a salinity problem. Some drain water sources, however, were between 0.7 and **1.7 dS/m and** these may contribute to crop salinity problems. Field water and soil EC levels increased significantly from top to bottom basins. Each declined significantly from June to August. Significant differences in water flow and depth between top and bottom basins and from June to August are probable explanations for these salinity differences. Rice yields decreased with increased salinity and were significantly lower in bottom basins compared to top basins. Seedling density and biomass decreased with increased water EC.

INTRODUCTION

California rice is grown using a continuously flooded culture. Historically, most rice producers have used a conventional "flow through" system to grow their crop. The system allows water to flow continuously through a series of basins starting at the top of the field and ending at the bottom. Water flow and depth are regulated by weirs in each basin and any excess water in the bottom basin may spill into a nearby drain ditch. This system allowed growers to maintain a constant water depth in their fields, but also resulted in pesticide residue contamination of public waterways.

Recent regulations have required growers to block their field water outlet and hold their irrigation water on field for up to 30 days after a pesticide application. This improved water quality by allowing the chemicals to degrade and dissipate in the field, but limited grower water management flexibility. To improve water quality and irrigation water management flexibility many growers have shifted from the conventional system to several closed irrigation systems. Long holding periods and closed irrigation systems have nearly eliminated pesticide water quality problems but may have contributed to salinity problems in **some** areas.

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Previous studies have shown that closed irrigation systems can be used with little or no salinity problem at low salinity sites, but that problems may exist at higher salinity sites.

Some growers on the westside of the Sacramento Valley have had problems with rice seedling establishment and reduced grain yields and have expressed concern about possible salinity problems during the long water holding periods. Preliminary studies have shown that some fields have higher salinity levels, especially at the bottom end of fields, which may be the cause of these problems.

The main objectives of these surveys were to evaluate the quality of irrigation water sources, assess water and soil salinity levels in area rice fields and to determine the effect of salinity on rice seedling establishment and growth, and grain yields.

METHODS

A salinity study was conducted from 1993 to 1995 to assess possible salinity problems on rice. The study included surveys of irrigation water sources and rice fields on the westside of the Sacramento Valley in Colusa and Glenn Counties (fig.l). Samples were collected in June, July and August. The irrigation water survey included irrigation district and drain water sources at 13 locations. The rice field survey included 27 fields. Each year field water samples were collected from marked inlet, top and bottom basin locations of each field. In 1994 and 1995, soil samples were also collected from the same top and bottom basin locations.

Rice yield samples were also gathered in 1994 and 1995 from the salinity sample sites. Another field study was conducted in 1993 to assess the effect of salinity and other factors on rice seedling establishment and growth. A total of 42 locations from three rice fields were sampled in this study.

RESULTS AND DISCUSSION

Water Source Survey. The results show that the Electrical Conductivity (EC) of all irrigation district sources surveyed was below 0.7 dS/m (deciSiemens/ meter) which is below the FAO water quality guideline for irrigation water salinity problems. Water from Glenn-Colusa (GCID), Provident (PID), and Princeton-Codora-Glenn (PCGID) Irrigation Districts had the lowest EC levels ranging between 0.13 and 0.3 1 dS/m, while Maxwell Irrigation District (MID) had slightly higher levels (0.48 - 0.60 dS/m). Some drain water sources, however, had salinity levels above the 0.7 dS/m guideline and may contribute to salinity problems on rice and other crops (fig. 2). The EC of water in the upper Colusa Basin Drain between Highway 162 in Glenn County (CBDl) and Maxwell Rd. in Colusa County (CBD3) was relatively low (0.42 - 0.66 dS/m), while the EC of the lower Colusa Drain at the Davis Weir (CBD5) was considerably higher (0.73 - 1.22 dS/m). Hopkins Slough also had higher EC levels (1.11 - 1.47

dS/m). Irrigation water between 0.7 and 3.0 dS/m is considered to cause slight to moderate salinity problems.

Rice Field Survey. Results showed that water and soil EC levels were significantly higher in bottom basins compared to top basins. Top basin water EC was also about equal to the inlet irrigation water. Figure 3 shows this for the early season (June) sample date.

Bottom basin water and soil EC levels were higher than top basins at all sample times and declined over time (fig. 4). The difference in top and bottom EC was probably due to the higher water flow observed in top basins compared to bottom basins. The EC decline in all basins over time was also due to increased water flow from early to late season. Water EC differences between the top and bottom also narrowed over the season. This was probably due to the greater late season increase in water depth (5 cm) in bottom compared to top basins. Overall, this helped dilute salts.

Intensive water EC monitoring results from one survey field are shown in figure 5. Water EC levels were lowest at the top, highest at the bottom and intermediate in the middle basin. Salinity levels increased rapidly, especially in the bottom basin, during the pesticide water holding period. During this period water flow was restricted and water depth decreased from evapotranspiration losses. Bottom basin EC levels improved rapidly, even before the end of the water holding period, when water was added and depth increased in the basin.

The higher EC levels in bottom basins indicate that salts are concentrating at the lower end of fields. In some fields the EC level was high enough in the bottom basin that seedling establishment and growth were greatly affected. This was observed in several higher EC fields and is shown in figure 6. Most of the problem fields were associated with higher EC drain water sources.

Grain Yield. **Rice** was harvested from the top and bottom basins of the 27 survey fields in 1994 and 1995 to assess the effect of water and soil salinity on yield. The mean grain yield for top basins was 10,300 lbs./acre compared to 9,700 lbs./acre for the bottom basins. This 600 lb. difference was statistically significant at the 0.0 1 level.

The 1994 data shows that both soil and water salinity are correlated with yield, but that early season soil salinity has the strongest correlation. The grain yield and soil salinity relationship is shown in figure 7.

Rice yield decreased significantly when early season (June) soil EC levels were higher than 2.0 dS/m (fig. 8). This is proposed as a tentative damage threshold level for California rice.

Rice Seedling Study. In a separate field study conducted in Colusa County in 1993 water EC levels were shown to effect rice seedling establishment and growth. The data shows that the number of seedlings established decreased as the EC level increased (fig. 9). They also show that seedling growth, as measured by biomass or plant dry weight, also decreased as the EC level increased.

Significant reductions in rice seedling density, caused by salinity, may be a major component of yield loss.

CONCLUSIONS

- While most water sources had low EC levels, some recycled drain water sources had moderate EC levels.
- Most fields with salinity damage were associated with moderate EC recycled drain water.
- Top basin rice field water EC was equal to the irrigation water delivered to fields .
- However, rice field water and soil EC increased significantly from top to bottom basin.
- Lower water flow in bottom basins compared to top basins, especially during pesticide holding times (- 30 days), is believed to be the main cause of higher water and soil EC levels in bottom basins.
- Seedling establishment and growth decreased with increased water EC.
- And, rice grain yield was significantly lower in bottom basins, compared to top basins where soil and water EC levels were highest. Rice grain yield decreased when the early season soil EC exceeded 2.0 dS/m.

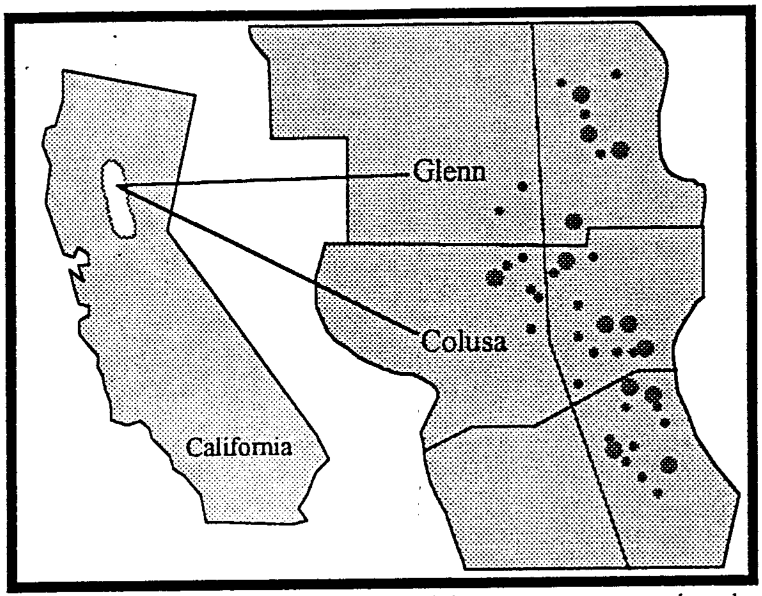

Figure 1. Water source and rice field salinity surveys were conducted on the westside of the Sacramento Valley in Colusa and Glenn Counties. Water source locations (13) are shown in large dots ● and rice field locations (27) as small dots .•

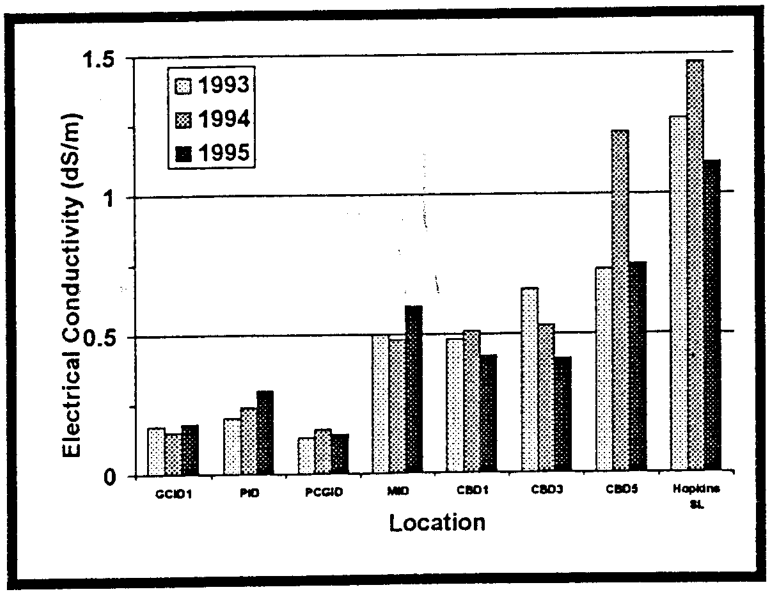

Figure 2. The mean water EC of selected irrigation district and drain water sources is shown for 1993 -1995.

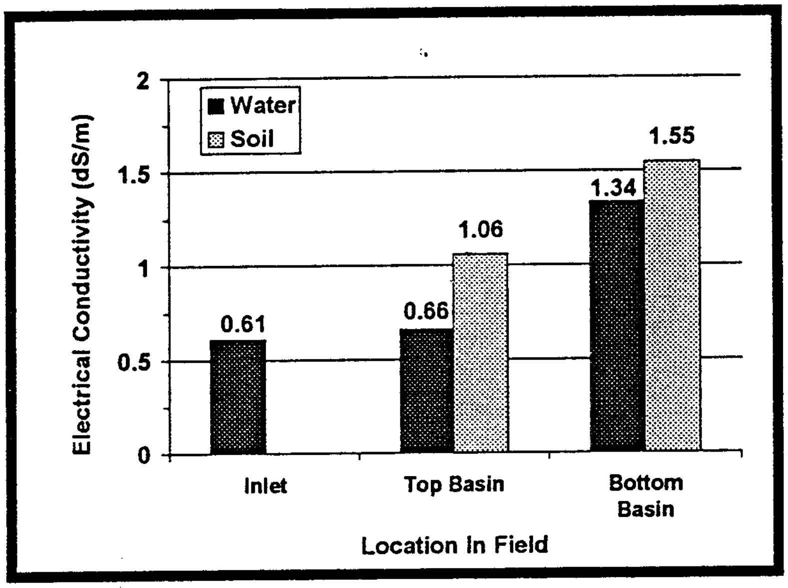

Figure 3. The water and soil EC at the inlet, top and bottom basins of 27 survey fields sampled in June of 1994 and 1995.

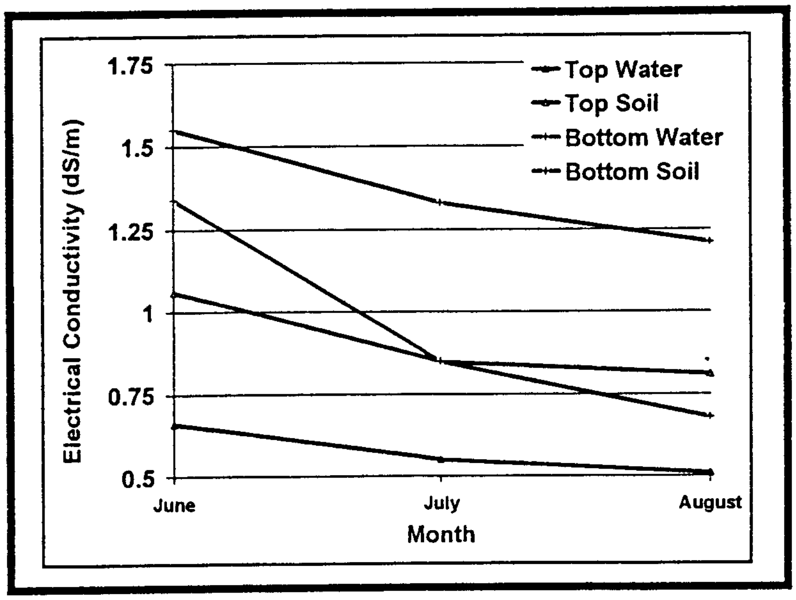

Figure 4. Top and bottom basin water and soil EC levels from 27 survey fields, 1994 to 1995.

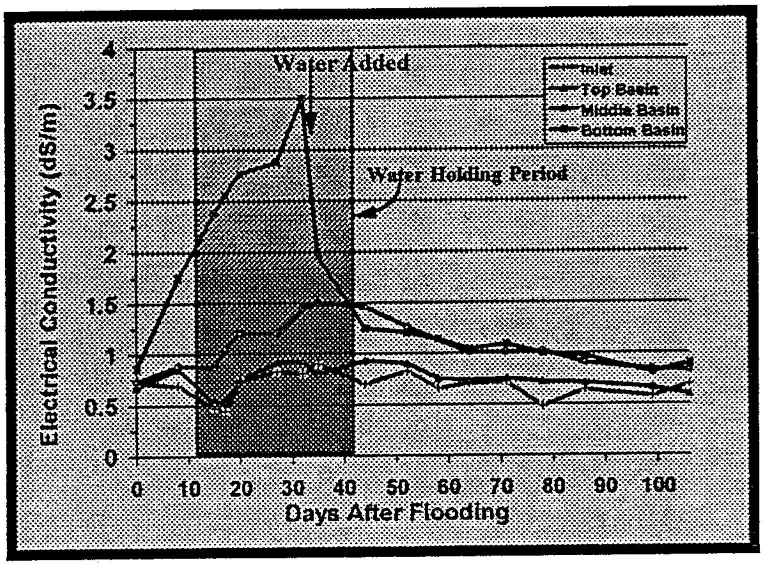

Figure 5. The EC of rice field water at the inlet, top, middle and bottom basins of one survey field is shown.

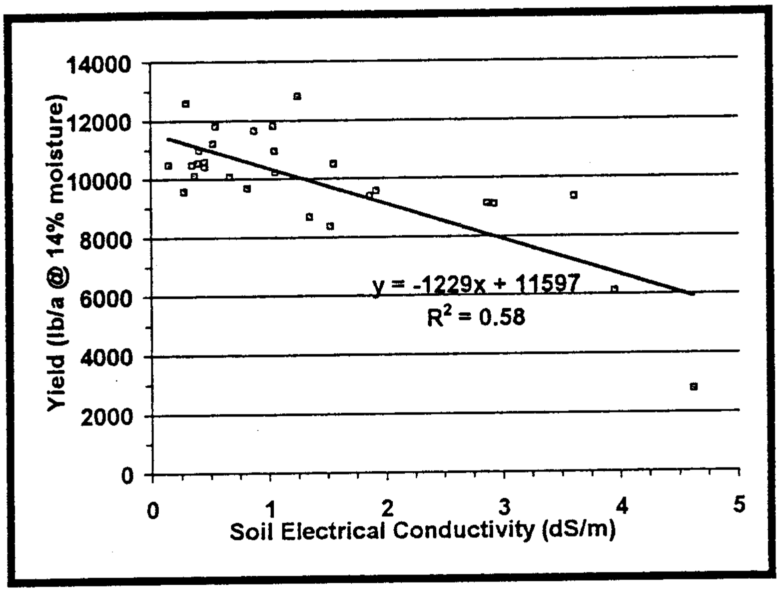

Figure 7. Rice grain yield from 27 rice fields declined with increasing soil EC levels.

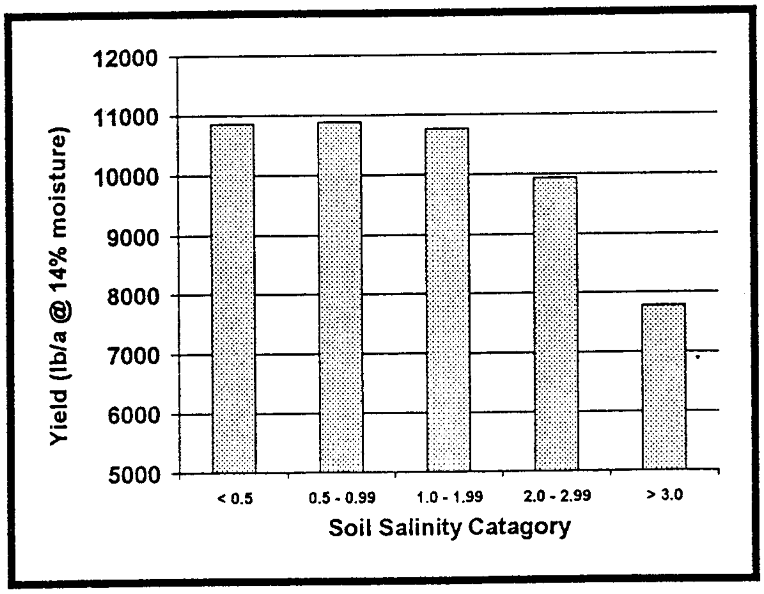

Figure 8. Rice grain yield is shown by soil salinity catagory. Yields were significantly lower at EC levels at 2.0 dS/m and above.

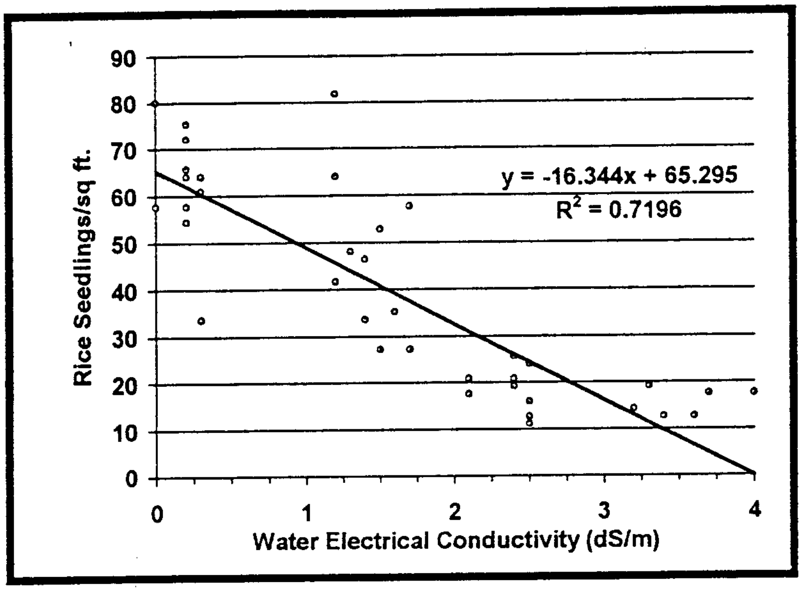

Figure 9 . Rice seedling density declined with increasing water EC levels.