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Effect of Preplanting Irrigations on Distribution of Soil Nitrate Nitrogen and Total Soluble Salts in Lettuce Beds[1]

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Abstract. **A preplant N application and the 2 irrigation methods most commonly used in Arizona to germinate commercially grown lettuce (*Lactuca sativa* L.) were studied in relation to the movement of soil NO_3-N and total soluble salts (TSS) in lettuce beds. The intermittent pattern of irrigation resulted in highest levels of TSS at all sampling depths two weeks after the germination and emergence of the lettuce. Total soluble salts and NO_3-N concentrations were increased by irrigation and were greatest in the surface 5 cm and center of the bed. Nitrogen application increased the amount of NO_3-N found in the lettuce beds. Neither irrigation nor N treatment caused any accumulation of NO_3-N in the area of the beds where the lettuce seedlings usually grow. The distribution patterns indicate that preplant N applications would be ineffective in meeting the early N needs of the plants.**

The irrigation method most commonly used to establish a stand in commercial lettuce fields in Arizona is to apply irrigation water in the furrows between the beds long enough so free water is maintained until the germination and emergence processes are completed. Crops are planted by placing seeds in dry soil in 2 rows, 36 cm apart, atop beds that are spaced 102 cm on centers. The time required for emergence in the early fall is 5 to 10 days. An alternative method is to apply irrigation water and maintain enough free water in the furrows until the beds are saturated. This takes from 18 to 24 hr, depending chiefly upon the condition and type of soil. The water application is then stopped. When the lettuce plants begin to emerge, water is again applied to moisten and soften the soil and aid in emergence. Under hot, dry and windy conditions a third irrigation may be needed.

The purpose of this investigation was to study the movement of soil NO_3-N and TSS in lettuce beds and to determine the effectiveness of applying N fertilizers ahead of bedding, using the previously described irrigation methods.

Other studies involving salt movement in lettuce beds using sprinkler irrigation have been conducted. The data (unpublished) indicates that the TSS in the soil samples taken from the 5 to 15 cm and the 15 to 30 cm depths was about the same as that found in the irrigation water, but nearly twice that found in the 0 to 5 cm samples. This increase has been associated with the capillary rise and salt deposition from the soil solution at the surface in the evaporation process.

Materials and Methods

The soil at the experiment site is a Glendale silty clay loam. A broadcast application of 56 kg N/ha as NH_4NO_3 was applied to one-half of the test area ahead of listing and bedding. Each plot consisted of 5 beds, 102 cm on center. Irrigation water was applied simultaneously to the furrows of the entire test area. A continuous supply of free water was kept in the furrows on one-half of the area for 5 days. The other half was watered initially for 24 hr, stopped and reapplied at the beginning of the fourth day for another 24-hr period. Thus, treatments were: (a) continuous irrigation without added N, (b) continuous irrigation with added N, (c) intermittent irrigation without added N and, (d) intermittent irrigation with added N.

Colorado River water with 864 ppm TSS, less than 0.25 ppm NO_3-N and a pH value of 8.2 was used to irrigate the plots.

Soil samples were taken 3 times from each of the 3 inside beds of each plot: once after bedding and before applying the water, 5 days after the first irrigation and 19 days after the first irrigation. For sampling purposes, each bed was divided into 3 levels: 0 to 5, 5 to 15 and 15 to 30 cm, with the soil at each level sampled across the entire bed. The top level was sampled in 10 5-cm squares, the second level in 5 10-cm squares and the lower level in 5 15-cm squares.

The samples were air dried and ground to pass a 2-mm sieve. Soil NO_3-N was extracted with water at a 1 soil: 5 water ratio and the extract analyzed using the phenoldisulfonic acid method of Johnson and Ulrich (3). TSS values, expressed as ppm in the saturation extract, were determined by the method outlined in Agricultural Handbook 60 of the U. S. Salinity Laboratory (4). Electrical conductivity values were converted to ppm as outlined by Bower and Wilcox (1).

Results and Discussion

The N application made prior to listing and bedding increased TSS in the 0 to 5 cm zone at all sampling dates when intermittent irrigation was used (Fig. 1, 2). The N application increased TSS in the 0 to 5 cm zone at the last sampling date in the continuous irrigation treatment.

Irrigation treatments resulted in a redistribution of TSS similar to that reported by others (2, 5, 6) studying salt movement in beds with furrow irrigation. In this test it was found that TSS began concentrating in the center of the bed by the second sampling date. Continued redistribution of the TSS occurred as the gravitational water moved down and out of the beds, followed during the drying process by a capillary rise of water with the movement to and deposition of additional salt in the top of the bed. This caused the greatest amount of TSS to accumulate in the top 2 inches of the center of the bed.

In the lower zones the water movement pattern was such that TSS were also most concentrated in the center of the bed (Fig. 2). Nitrogen treatment had little influence on TSS relationship at the 2 lower levels and more accumulated in the center of the beds in these zones with the intermittent irrigation than with continuous irrigation.

Redistribution of NO_3-N in the beds was much like that of TSS (Fig. 3, 4). The application of N prior to listing resulted in a 2-fold NO_3-N increase in the top 5 cm of the bed at the first sample date. Irrigation treatments accounted for most of the NO_3-N being concentrated in the center of the bed. Due to the application of N there was a 2- to 3-fold increase in NO_3-N in the top 5 cm of the bed at the last sampling date. Soil temp (24°C) and soil moisture were nearly ideal for the rapid nitrification of much of the applied NH_4-N between the last 2 sampling dates. The intermittent irrigation method concd more

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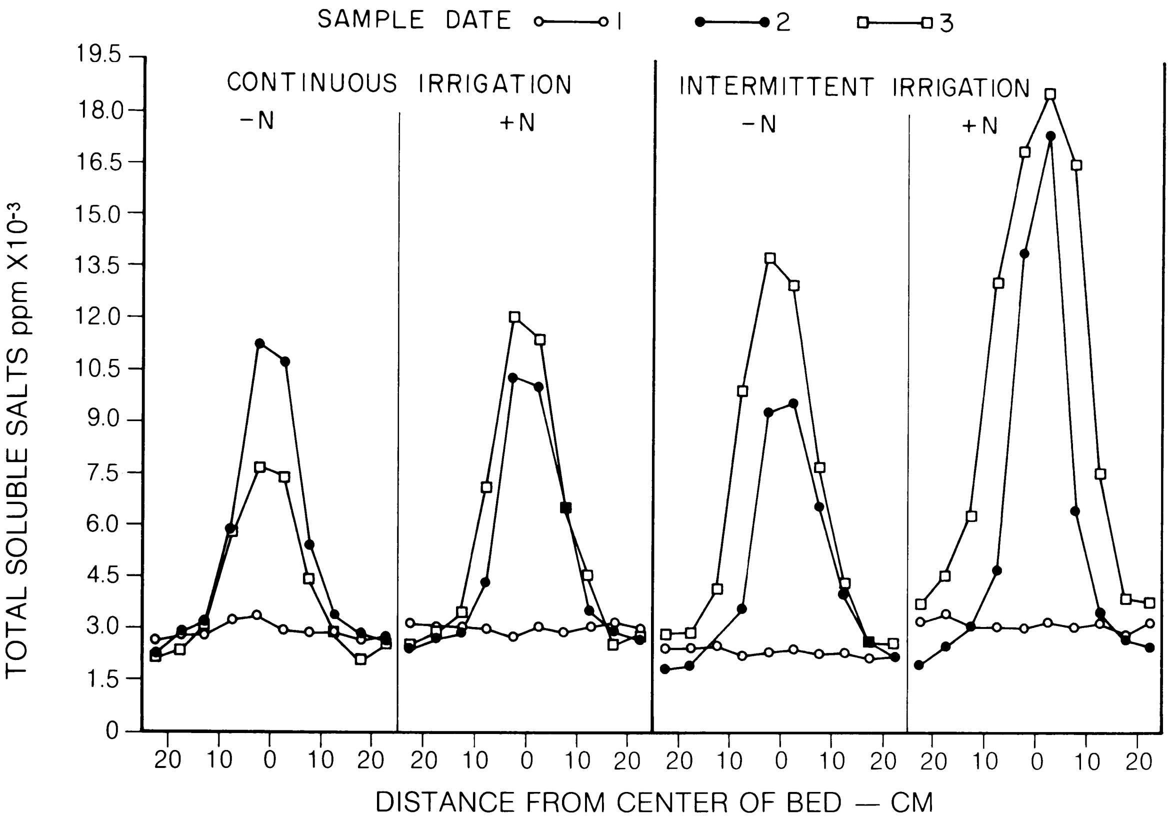

Fig. 1. Total soluble salts in lettuce beds at the 0-5 cm level. LSD for sample 5 cm right of center = 2008 ppm.

NO_3-N in the top and center of the beds than did the continuous application method. Irrigation and/or N treatment affected the NO_3-N distribution in the bed at the 2 lower levels for the first 2 sampling dates (Fig. 4). However, neither irrigation nor N treatment affected the amount of NO_3-N found at these levels at the last sampling date.

While data for the first 2 sampling dates are only of academic interest, the distribution and concn of NO_3-N and TSS at the last sampling date are of specific practical interest because they affect the growth of lettuce plants. Calculations showing the

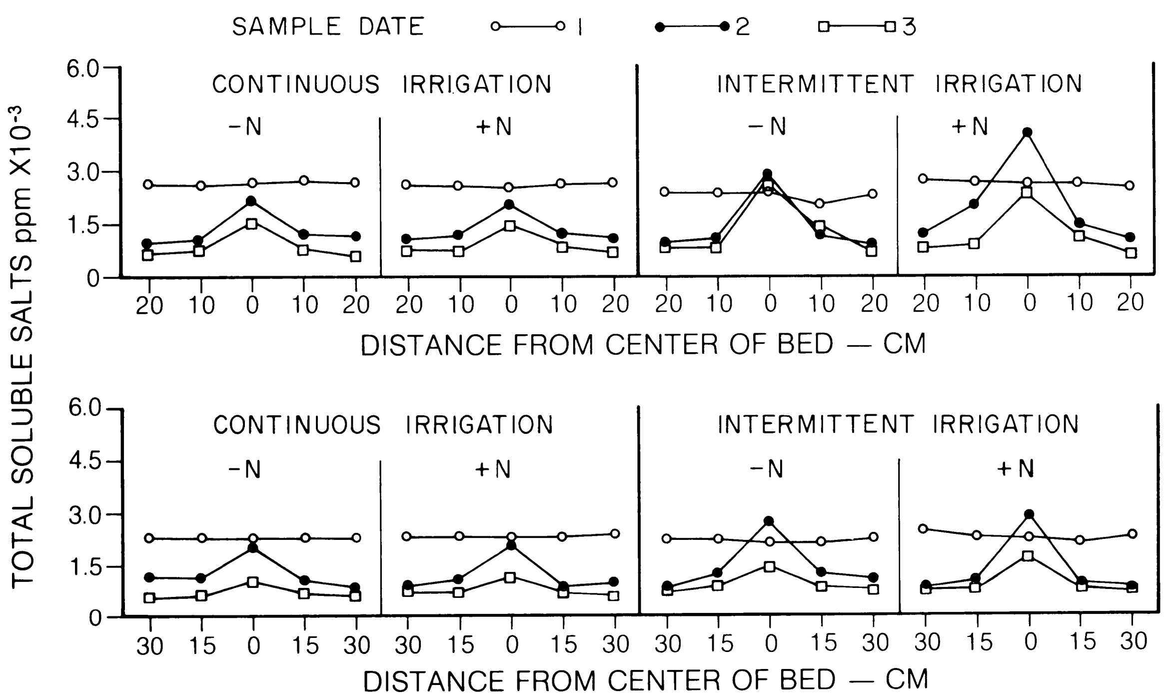

Fig. 2. Total soluble salts in lettuce beds at the 5–15 cm level (top) and 15–30 cm level (bottom). LSD center sample = 388 ppm (top). LSD center sample = 301 ppm (bottom).

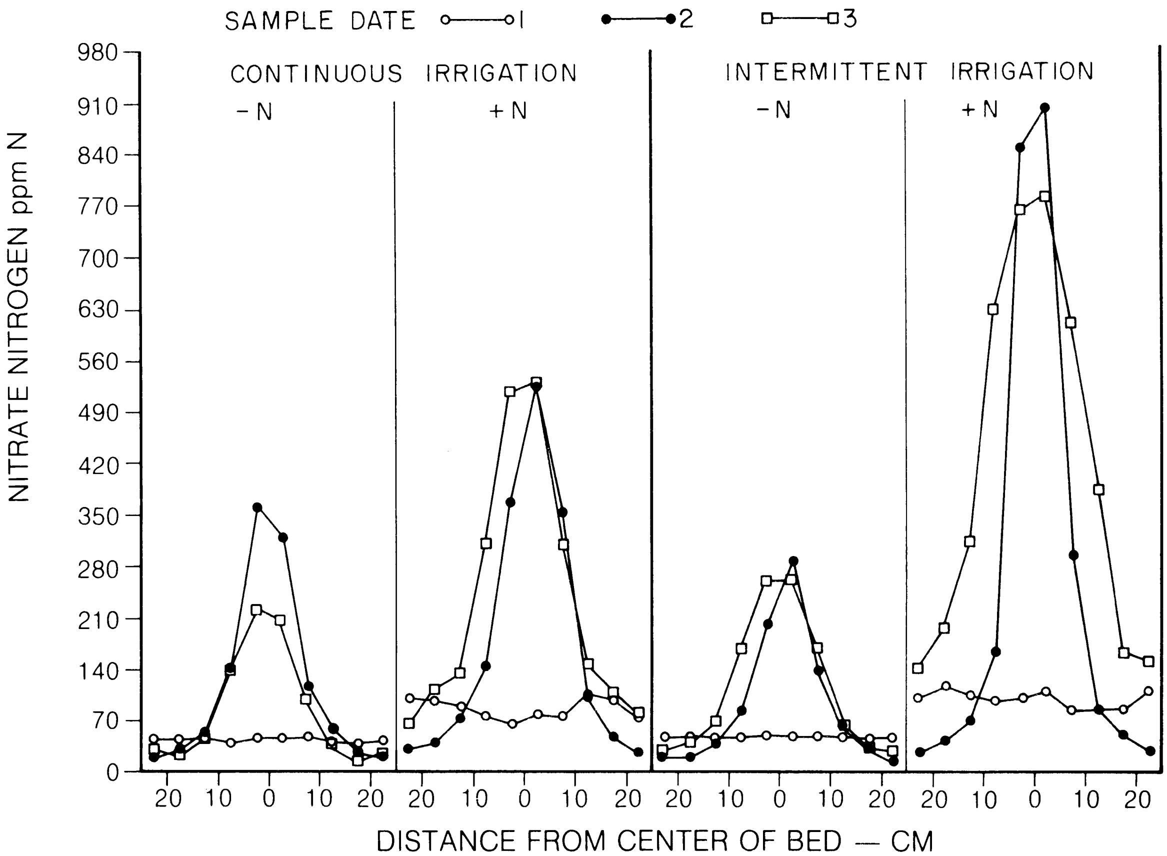

Fig. 3. Nitrate nitrogen in lettuce beds at the 0–5 cm level. LSD for sample 5 cm from center = 43 ppm.

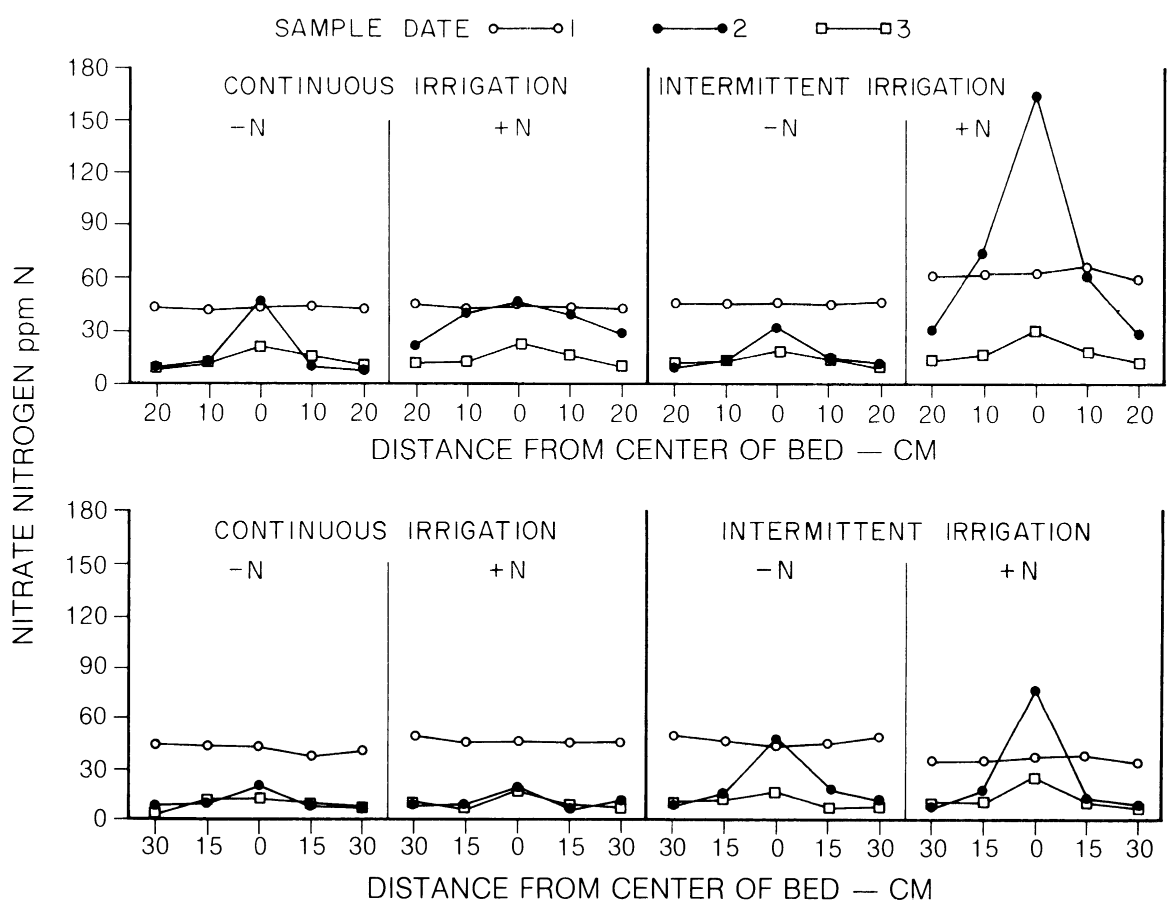

Fig. 4. Nitrate nitrogen in lettuce beds at the 5–15 cm level (top) and 15–30 cm level (bottom). LSD for center sample = 9.5 ppm (top). LSD for center sample = 4.6 ppm (bottom).

levels of TSS and NO_3-N present in the bed indicate that the intermittent irrigation treatment resulted in accumulating one-third more TSS than the continuous type. Nitrogen applications increased the TSS in the top 5 cm but had no effect on TSS at the other sampling levels. Intermittent irrigation also increased the NO_3-N found in the beds at the last sampling date. Without added N, the intermittent irrigation resulted in 22% more NO_3-N in the bed and 62% more NO_3-N when N was added. Most of the increase in NO_3-N was found in the top 5 cm, particularly in the center of the beds. Nitrogen applications increased the NO_3-N by 102% with continuous irrigation and 168% with intermittent irrigation. Of this increase, 96% was found in the top 5 cm of beds irrigated continuously and 85% when irrigated intermittently. Without the addition of N, the NO_3-N in the beds at the third sampling date showed that 50% and 45% of the amount found in the first sampling was leached below the sampling zone by continuous and intermittent irrigation, respectively. When N was added, 21% of the NO_3-N originally present was leached by continuous irrigation, whereas with the intermittent irrigation there was a 13% increase in NO_3-N. The additional NO_3-N added to the beds, plus that resulting from nitrification of the added NH_4-N, likely influenced this difference in the amounts leached.

Conclusions

While certain treatments resulted in more NO_3-N in the beds than others, most of it was concentrated in the center of the top 5 cm. Regardless of treatment there was little difference in NO_3-N concn in the area where the roots of the small lettuce plants usually grow. In this area the uniformly low concn would indicate that N applications ahead of listing would be ineffective with the types of germination irrigations used in these studies. The low NO_3-N concn found in the root zone where young lettuce plants usually grow accounts, in part, for the N deficiencies often observed in young lettuce plants, despite preplant N applications. The NO_3-N in the center of the beds where the greatest amount is located would not be available to or utilized by the plant until the plant root system is large enough to occupy this area. Further, only a small amount of this N would be available for use unless a rain moves it from the surface depths down into more of the root zone. Since these data indicate that preplant applications of N would be ineffective for lettuce seedling growth, early sidedress applications are usually necessary to insure appropriate early development.

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The Potential Use of Antitranspirants in the Greenhouse Production of Chrysanthemum[1]

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Abstract. **Three film-forming antitranspirants were applied to potted chrysanthemums (*Chrysanthemum morifolium* Ramat.) under greenhouse conditions from the time of potting rooted cuttings to saleable size. Folicote (a hydrocarbon wax emulsion of essentially fully refined paraffin) reduced water loss by an average of 39% and by as much as 65%, but generally detracted from plant appearance, delayed flowering, depressed fresh and dry weight, decreased flower size, increased height and reduced leaf area. While Clear Spray (a lateral based emulsion of undefined composition) and Wilt Pruf NCF (whose active ingredient is a polyterpene compound, Pinolene) reduced water loss 8 and 11% respectively, their side effects were less deleterious and, in a few cases, beneficial. Effects of antitranspirants under summer greenhouse conditions appeared to be of a greater magnitude than during a cooler season of the year.**

Because of limited soil volumes, plants in pots are susceptible to moisture stress during their production, particularly following transplanting and during hot summer conditions. Small pots pose even greater watering problems and they do not readily lend themselves to most automatic watering systems. It was thought that suitable film-forming antitranspirants, applied during production of potted crops, might alleviate watering problems.

Much of our knowledge of plant antitranspirants has been summarized by several authors (5, 6, 9, 12, 14). Various latexes, plastics, resins, silicones, and waxes have been studied for antitranspirant properties. A number of these have substantially reduced transpiration but often with side-effects, many of which are undesirable. This research was initiated to study the long-term effects of repeated antitranspirant application on plant production.

Materials and Methods

The study consisted of 2 tests, one conducted during an

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