CONSUMPTIVE USE AND SALT ACCUMULATION WITH TRICKLE IRRIGATION ON ROW CROPS

by

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ABSTRACT

Agriculture uses more than 83 percent of all water consumed in the United States west and a similar percentage in New Mexico. Trickle (drip) irrigation offers considerable potential for saving irrigation water while maintaining or even increasing yields. However, little information is available on water use of trickle irrigated crops. In view of the economic importance of chile peppers, a study was initiated to determine the effects of water use and salinity on trickle irrigated chile peppers.

This report summarizes results of research conducted over a seven-year period on water use and salinity aspects of trickle irrigation. The major findings from these projects are published in various journal articles and theses listed under References. In addition, each article is briefly described under the Introduction Section of this report.

The study was conducted at the Plant Science Research Center of New Mexico State University. Plots were irrigated through bi-wall trickle tubing buried 10 cm below each crop row. Replicate plots were irrigated at rates equal to 0.6, 0.8, 1.0, 1.2 and 1.4 times the rate applied to control plots.

A maximum yield of 37.2 t/ha of green chile was obtained with 94 cm water, which includes 13 cm rainwater. Yields did increase linearly with irrigation water applied up to the maximum yield. Yields were less for the wettest treatment due to lack of aeration. The optimum tension for maximum yield was about 250 cm at 20 cm below the trickle line. The mean soil salinity in soil with trickle irrigated chile showed little increase over a five-year period, indicating that trickle irrigation of row crops does not have to lead to high salt levels in the plant root zone.

Key words: Trickle irrigation, salinity, tension, water management, field studies

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INTRODUCTION

Agriculture uses more than 85 percent of all water consumed in the West. Water in the arid Southwest is scarce, expensive and often of low quality. Wise use is of mutual benefit to all sectors of the population both from a conservation viewpoint and increasingly in terms of economic considerations.

Trickle (drip) irrigation offers the potential for increasing crop production with less water than alternative irrigation systems. The benefit of obtaining more yield with less water is most likely to occur where energy and water are expensive, on sandy soils of low water-holding capacity, and in a harsh arid environment. This irrigation efficiency results because by delivering water directly to the root zone with a high frequency, the system is more closely controlled, runoff is non-existent and deep percolation is lessened. Two disadvantages to the system include the high initial setup costs (Wilson et al. 1984) and the necessity of a high level of management and maintenance including salinity control.

This report summarizes results of research condcuted over a seven-year period on water use salinity aspects of trickle irrigation. The major findings from these projects are published in the articles and theses listed below along with a brief description of the research.

1. Fowler, J. L. and P. J. Wierenga. 1979. Cotton response to two water application levels under trickle irrigation. N. M. Agr. Exp. Sta. Res. Rpt. no. 392. Water use efficiency was affected by row spacing and irrigation level; yields were higher for the well watered treatment.

2. Aguire Luna, O. 1979. Observed and simulated 2-D soil temperature distributions under trickle-irrigated chile. Unpubl. Ph.D. Thesis. Department of Crop and Soil Sciences. New Mexico State University. pp. 242. A model was developed to describe two dimensional heat transfer in soil. Model predictions were compared with measurements made in a field with trickle irrigated chile peppers.

3. Panpruik, P. 1980. Effects of nitrogen and phosphorus on trickle irrigated chile. Unpubl. M.S. Thesis. Department of Crop and Soil Sciences, New Mexico State University, pp. 79. Application of 0, 112 and 224 kg N/ha through the trickle system significantly affected the nitrogen contents in leaves and petioles, but had no effect on green and red chile yields. Phosphorus applied as either orthophosphoric acid or glycerol phosphate did not affect yields.

4. Hibner, P. 1982. Salt movement under trickle-irrigated row crops. Unpubl. M. S. Thesis. Department of Crop and Soil Sciences, New Mexico State University. pp. 124. Soil samples were taken at the end of each growing season during 1976 through 1982 and analyzed for salinity and chloride concentration. There appeared to be no significant increase in total salinity of the soil. Salts move from the trickle lines into the furrows from where they leach to the subsoil.

5. Horton, R., F. Beese, and P. J. Wierenga. 1982. Physiological response of chile pepper to trickle irrigation. Agron. J. 74:551-556. Although there were significant differences in water use by treatments receiving 80, 120 and 140% of the

water applied to a control treatment, differences in plant water potential and stomatal resistance were minimal. Chile peppers appeared to adapt to the soil water supply by controlling plant size.

6. Post, S. 1982. Soil temperature, planting date and the growth and development of trickle-irrigated chile (*Capsicum annuum* L.). Unpubl. M. S. Thesis. Department of Crop and Soil Sciences, New Mexico State University, pp. 104. Planting date had a strong effect on emergence, plant development and green chile yields. Emergence took as much as 20 days when planted on March 10 and 7 to 9 days when planted after April 9. Optimum planting date in terms of yield appeared to be between March 20 to 30. Late planting resulted in significantly lower green chile yields.

7. Panpruik, P., B. D. McCaslin, and P. J. Wierenga. 1982. Effects of nitrogen and phosphorus fertilizer on yield and leaf content of trickle irrigated chile peppers. N. M. Agric. Exp. Sta. Research Rpt. #480, pp. 5. Results showed that when NO_3-N content is maintained above 1000 ppm in chile leaves and above 4000 ppm in the petioles through mid-season, yields in the Mesilla Valley may not be reduced.

8. Beese, F., R. Horton, and P. J. Wierenga. 1982. Growth and yield response of chile pepper to trickle irrigation. Agron. J. 74:556-561. Lower rates of water application resulted in lower rates of leaf area development and dry matter production and in lower yield of above and below ground plant parts. Water use efficiencies varied little between water

treatments. Thus, although limiting the amounts of water applied reduced final yields, water use efficiencies were not affected.

9. Saddiq, M. H. 1983. Soil water status and water use of trickle irrigated chile pepper. Unpubl. Ph.D. thesis. New Mexico State University, 250 p. Soil evaporation was a small fraction (7-10%) of the total water used, once the leaf area index became greater than 1.0. Actual evapotranspiration did not decrease below potential evapotranspiration until soil water tension became greater than 200 cm H_2O. There was a good correlation between crop water stress index and soil water tension and available soil water.

10. Wierenga, P. J. 1983. Yield and quality of trickle irrigated chile. N. M. Agricultural Experiment Station. Bulletin 703, 16 pp. Yield of trickle-irrigated green and red chile was found to increase with the amount of irrigation water applied, with maximum yield obtained for the treatment that received 20% more than the control treatment. Yields started to decrease when 40% more water was applied than to the control treatment. A total of about 32 inches of water are needed for optimum yields of trickle irrigated chile.

11. Hendrickx, J. M. H. 1984. Experimental design and results of water use studies for trickle-irrigated chile pepper. Unpubl. Ph.D. Thesis. Department of Crop and Soil Science, New Mexico State University, pp. 124. An equation was developed for evaluation of the optimal number of

replications and/or the optimal plot size for field experiments with structured quantitative treatments.

12. Wierenga, P. J. and J. M. H. Hendrickx. 1984. Yield and quality of trickle irrigated chile. Agricultural Water Management, 9:339-356. A linear relationship was found between water use and yield of trickle irrigated chile. Maximum yields occurred when 80 to 95 cm of water was applied. Trickle irrigated chile should not be stressed during the growing season to save irrigation water. Chile pungence was related to water management, with more pungent chile in drier soils.

13. Wierenga, P. J. and M. H. Saddiq. 1984. Optimum soil water tension for trickle irrigated chile peppers. Proc. 3rd Intern. Drip/Trickle Irrigation Congress. Nov. 17-21, Fesno, CA. 193-198. Optimum range of the average soil water tension in Glendale clay loam was between 150 and 250 cm, for tensiometers placed at 15, 30 and 50 cm below soil surface (averaged over all three depths). It appears that the optimum range of soil water tension is considerably lower in trickle irrigated fields than in flood irrigated fields.

LITERATURE REVIEW

Up-to-date and comprehensive discussions of trickle irrigation include the Proceedings of the Third International Drip/Trickle Irrigation Congress held in November 1985 at Fresno. Two volumes were published including about 150 papers on all aspects of trickle irrigation. Major headings include perspectives, economic considerations, clogging, experiences in the USA, experiences on an international scale, crop production/response, field evaluation, product testing, fertilization, design, insect and weed control, nursery and landscaping, comparison to alternative methods, systems and equipment, use with saline water, root system development, infiltration factors, scheduling, uniformity and subsurface applications.

Comprehensive reviews of trickle irrigation are by Howell et al. (1980) and by Bucks et al. (1982). Advantages of trickle irrigation cited by Bucks et al. are: (1) increased beneficial use of available water, (2) enhanced plant growth and yield, (3) reduced salinity hazard to plants, (4) improved fertilizer and other chemical applications, (5) limited weed growth, (6) reduced labor for operation, (7) decreased energy requirements, and (8) improved cultural practices.

Although trickle irrigation has been used on many crops there is a lack of information on water use of chile peppers (capsicum annuum L.) irrigated with the trickle system. In view of the importance of chile peppers for New Mexico's economy, a study was initiated to determine the effects of water use and salinity on trickle irrigated chile peppers. This report discusses the major findings from this study. More details can be found in the various journal articles and theses that resulted from this study listed under references.

MATERIALS AND METHODS

The study was conducted at New Mexico State University's Plant Science Research Center, about 14 km southwest of Las Cruces, NM. The soil at the experimental site is a Glendale clay loam (mixed, calcareous, thermic family of Typic Torrifluvent) with the water table at about 3 m. The soil consists of about 70 cm of fine silty clay loam overlaying fine-to-medium sands.

Experimental procedures were slightly modified over the years but not to the extent that they invalidated year-to-year comparisons. The experimental site was arranged each year in a randomized complete block design (Wierenga and Hendrickx 1985).

Plots were irrigated with trickle lines (Bi-Wall II Irrigation Tubing, Reeds Irrigation Systems, CA; Chapin Twin Wall, Watermatics, Watertown, NY) connected to header lines that ran through the center of the field. Trickle lines were between 5 cm and 8 cm below the surface of the row. Emitters were 30 cm apart.

Cultural practices consisted of plowing, disking and preparation of the beds. After trickle tubing was installed, the field was planted with chile peppers (*Capsicum annuum* L. var. New Mexico 6-4). The seeding rate was approximately 10 kg/ha and Furadan was applied at planting at a rate of 10 kg/ha. Nitrogen application rates varied between 100 and 200 kg/ha. Nitrogen was applied by injecting urea (30 percent N) directly into the main header line.

Initially, irrigations were scheduled on the basis of soil-water potential measurements using tensiometers. In later years, the amount of water applied to the control plots was determined from pan evaporation using an empirically determined pan factor, which was a function of the leaf area index as presented by Wierenga (1983). Treatments consisted of applying different amounts of water to the plots, varying between 60 and 140 percent of what was applied to the control plots.

Measurements taken included yield and quality of green and red chile (Wierenga 1983), and crop physiological parameters (Beese et al. 1982, Horton et al. 1982). Data on the salt distributions around the trickle lines and on the long term accumulation of salts in the soil irrigated by the trickle system were obtained by sampling the soil and determining its salinity in the laboratory (Hibner 1982). Soil samples were taken with a 5 cm hydraulic soil probe at 10 cm depth intervals to a depth of 50 cm from the top of the bed and the furrow bottom, respectively. Samples were taken before and after each irrigation season. More detailed sampling was done to determine the salt distribution around trickle lines at various times during the growing season.

The feasibility of multiyear use of trickle tubing was investigated in one experiment by chopping the plants during the fall or winter following each growing season and planting on the same row the next spring. The plots were not tilled between successive crops. Weeds were controlled by applying herbicides. In this experiment, chile peppers were grown the first year, followed by cotton the second and third years.

In 1983, the effect of row distance and amount of irrigation water were studied. Three water treatments with double rows per bed were compared with two water treatments with single rows per bed.

RESULTS AND DISCUSSION

Yields of green chile

Table 1 (Wierenga and Hendrickx 1985) shows the green chile yield for the years 1977 to 1983. In 1981, plots were harvested twice and the yield data represent the combined yields from the two harvests. In all other years, the plots were harvested only once. Data in Table 1 show a strong tendency of increasing yield with years. The increase is a result of at least two factors. First, higher yields are a result of the greater amounts of water used for irrigation in the latter years. Second, relatively high soil water tension during the first two years may have decreased yields because, in 1977 and 1978, the control treatments were not irrigated until the soil water tension at 20 cm below the trickle line reached 0.025 MPa equivalent to 250 cm H_2O. Detailed tensiometer measurements made during the 1981 season (Saddiq 1983) have shown that a soil water tension of 0.025 MPa at 20 cm is rather high for chile on the clay loam soil at the experimental site.

A previous study by Horton et al. (1982) reported chile pepper plants adapt to a low soil water supply by controlling their size. Plants in the drier irrigation treatments displayed less leaf area, fewer leaves per plant and less above ground dry mass production. Smaller plants use less water and, thus, dry out the soil to a lesser extent, resulting in lower soil water tensions. In 1979 through 1983, the standard evaporation pan was used to schedule irrigations and greater amounts of water were applied, resulting in improved yields.

In figure 1, green chile yields from single-row planting were plotted versus the total amount of water applied. In most years,

TABLE 1. Green chile yields[a] as influenced by irrigation treatment.

Treatment % of control	Water applied[b] (cm)	Yield (t/ha)	C.V. (%)
1977			
60	35.2	2.5	36.0
70	37.2	3.7	36.0
80	39.5	5.6	20.0
100	45.1	11.8	20.3
1978			
80	38.1	11.0	5.2
100	44.2	14.2	8.7
120	50.3	16.3	11.1
140	56.4	19.1	6.7
1979			
80	53.1	13.0	30.9
100	57.9	18.8	26.5
120	63.0	18.1	12.5
140	65.0	22.8	40.7
1980			
80	62.1	18.8	12.3
100	70.1	28.1	5.4
120	79.9	30.2	14.8
140	88.6	28.9	12.2
1981			
60	66.3	7.8	27.7
80	75.9	24.6	6.1
100	86.1	33.2	11.8
120	93.6	37.2	15.6
140	109.0	33.6	10.7
1982			
80	64.9	27.4	10.2
100	71.9	29.9	6.7
120	81.6	31.9	9.7
140	85.2	34.0	2.0
1983			
70	76.1	16.7	24.9
100	89.6	18.8	22.5

[a]The 1981 yields include the first harvest on 13 August and the second harvest on 14 September. The 100% treatments are the control treatments.

[b]Includes 10.3 cm rain in 1977, 3.6 cm rain in 1978, 14.3 cm rain in 1979, 9.8 cm rain in 1980, 12.8 cm rain in 1981, 9.4 cm rain in 1982, and 7.0 cm rain in 1983.

yields increased with larger amounts of water applied, with the exception of the data of 1983 and the lowest point in 1981, figure 1 shows a clear linear trend between the amount of water applied and green chile yield. The flat slope and the lower yields in 1983 may be caused by the soil at the experimental site of that year. The soil used in 1983 was more variable, and the coefficient of variability of yields was higher than before, for the same amount of applied water. The outlier found in 1981 is due to the fact that the green chiles were picked twice.

In 1980 and 1981, yields started to decrease for the 140 percent treatments, due to the wet soil conditions and the resultant lack of oxygen. In 1980, maximum production was 30.2 t/ha with 79.9 cm of water. In 1981, maximum production was 37.2 t/ha with 93.6 cm of water. Because a maximum yield was reached for the 120 percent treatment in 1980 and 1981, the 140 percent treatments during these years cannot be included for detection of the linear trend between amount of water applied and green chile yields over the years 1977 through 1982. Excluding the data of 1983, the outlier in 1981, and the 140 percent treatment data in 1980 and 1981, we find:

$$Y = -14.11 + 0.56D_{iw}, \qquad R^2 = 0.69 \qquad (1)$$

where Y is the annual production (t/ha) and D_{iw} is the depth of water applied (cm), including rain. Equation (1) indicates, for a trickle-irrigated field with single rows, each 10 cm additional irrigation water will increase green chile yields by 5.6 t/ha. The equation is valid up to the point where the maximum yield is obtained. Yield data of the years 1980 and 1981 indicate this maximum to be between 80 and 95 cm water applied, depending on the weather. When less than 80 cm

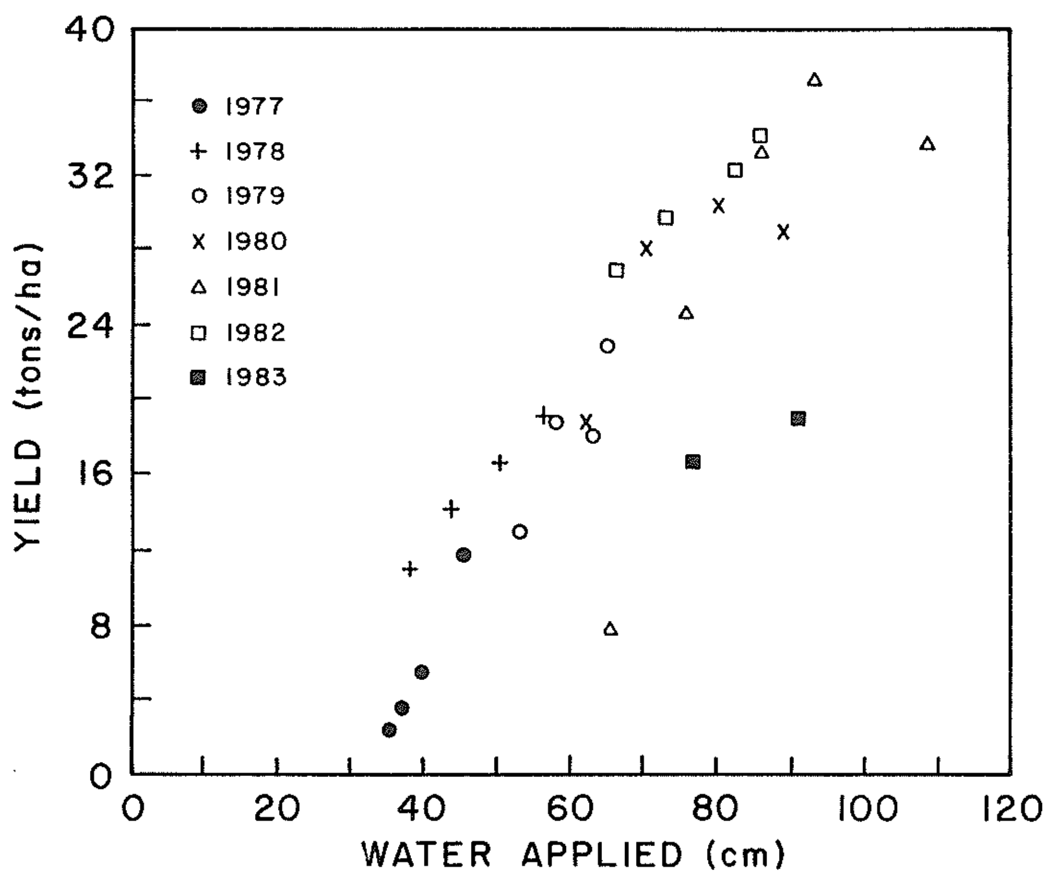

Figure 1. Yield of green chile versus water applied (rainfall included) for the years 1977-1983 with a single row per bid.

water was applied to the chile, deep percolation could be ignored and the total amount of water applied equaled the evapotranspiration. With more than 80 cm of water application, there may have been some deep percolation.

Yields of red chile

Table 2 shows the red chile yields for the years 1977 through 1981. As was the case for green chile, red chile yields also increased with greater amounts of water applied. However, the trend is not as clear as for the green chile yields. Red chile harvests in 1977, 1978 and 1979 included some nonmarketable chile, while in 1980 and 1981, only the marketable chile was harvested. A virus infestation also affected red chile yield in 1981, reducing yields as compared to the previous years. Furthermore, red chiles were harvested about two months later than the green chiles, which increased their growing season by about 60 days. However, the chile was irrigated during the first half of this 60-day period only. Because of the late harvesting date, fall weather may be expected to have a significant effect on red chile yields.

In figure 2, red chile yield is plotted versus the depth of irrigation water applied. Rain has not been included in this case, although there was significant fall rainfall. This rain did not replace irrigation water and probably had more of a negative effect on yields. Thus, inclusion of rain would distort the results. The data show a fairly wide scatter, which could have resulted from different management and harvest procedures used during the five-year study and from different fall weather conditions. In particular, yields before 1980 may be too high as a result of the inclusion of nonmarketable chile in the yields.

TABLE 2. Red chile yields[a] was influenced by irrigation treatment.

Treatment % of control	Water applied[b] (cm)	Yield (t/ha)	C.V. (%)
1977			
60	30.2	0.84	35.4
70	33.0	1.29	25.2
80	36.1	1.78	16.6
100	43.4	3.34	22.1
1978			
80	41.7	4.36	11.9
100	49.5	4.80	20.7
120	57.4	5.21	12.8
140	65.3	5.36	13.1
1979			
80	45.2	4.41	22.9
100	52.8	5.54	19.1
120	59.4	5.61	25.8
140	66.3	6.43	23.7
1980			
80	58.4	4.60	7.2
100	67.8	5.36	7.7
120	80.8	5.77	11.3
140	90.9	5.49	12.9
1981			
60	56.6	2.69	6.2
80	66.9	4.58	5.9
100	77.9	4.92	5.2
120	86.5	5.34	6.8
140	98.6	4.86	3.7

[a]The 100% treatments are the control treatments.
[b]Does not include 17 cm rain in 1977, 13.5 cm rain in 1978, 13.5 cm rain in 1979, 18.5 cm rain in 1980 and 12.8 cm rain in 1981.

All yields were adjusted to 8% water content.

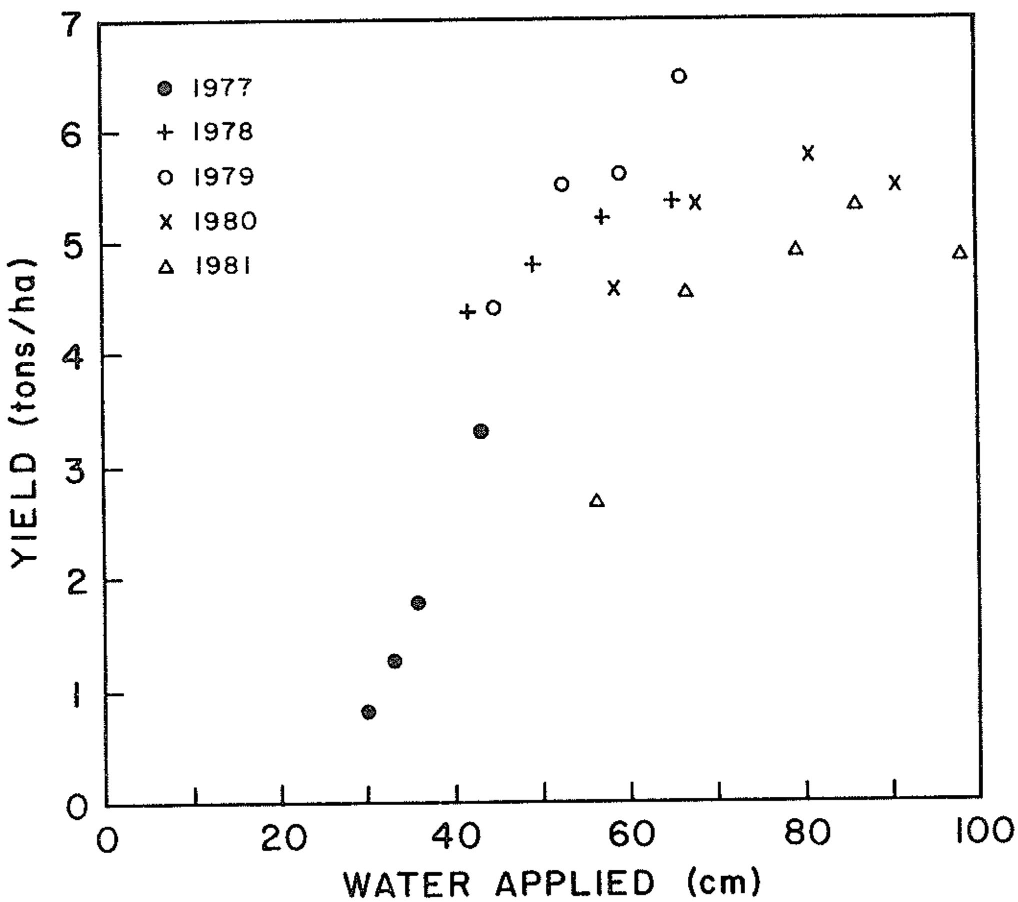

Figure 2. Yield of red chile versus water applied (excluding rain) for the years 1977-1981.

Nevertheless, there is a clear trend in the yield data indicating higher yields with more water applied until about 60-70 cm of irrigation water, beyond which yield increases in red chile are much smaller or nonexistent.

Cultural practices

The final yield of chile depends not only on amount of water applied, but also on cultural practices during the season. Two of these cultural practices were studied in 1982 and 1983; harvest date for green chiles in 1982, and the planting of two rows versus a single row per bed in 1983.

The influence of harvest data on final green chile yield can be seen in table 3. A wide range of yields is obtained, depending on the date of harvest. Higher yields than those shown in table 3 could possibly be obtained by harvesting later; however, by delaying harvest, chile may change color from green to red and lose its value.

The data in table 3 indicate that the effect of harvest date on total green chile yield can be important, especially if harvested only once. Harvesting twice does not necessarily increase total yield above that of a single harvest, provided the single harvest is timed properly. The merit of two harvest dates, about 10-20 days apart, is that the effect of harvest time on yield is less pronounced.

Results of single versus double row planting on yield are given in table 4. No difference is found between single and double row at the 70 percent treatment, but a significant difference at the 100 percent treatment indicates an interaction between row spacing and total amount of water applied. A similar interaction was found for drip irrigated

TABLE 3. Green chile yields on different harvest dates in 1982 (mean values of two plots)

Harvest date	Yield (t/ha)
9/82	19.0
20/82	24.8
30/82	39.2
9 and 30/82	38.2
20 and 30/82	29.7

TABLE 4. Green chile yields in 1983.

Treatment		Water applied	Yield	C.V.
% of control	row spacing	(cm)	(t/ha)	(%)
70	single	76.1	16.7	24.9
70	double	72.7	14.7	41.2
100	single	89.6	18.8	22.5
100	double	89.4	25.2	20.5
130	double	103.7	34.1	8.6

cotton by Fowler and Wierenga (1979). For both crops, yields increased with double row only if sufficient water was applied. Because the double row yields do not exceed green chile yields of single row from previous years, no conclusive proof is found that double row is indeed higher yielding than single row. Further experiments need to be conducted to verify the results.

Irrigation management

Table 5 shows the average soil water tensions observed during the 1981 growing season for the various irrigation treatments (Wierenga and Saddiq 1985). It is clear from table 5 that the soil water tensions respond nicely to the irrigation treatments, with the lowest tensions observed in the wettest treatments. It is somewhat surprising that the dry plots receiving only 60 percent and 80 percent of the water applied to the control plots remained within the tensiometer range. One would expect the soil in plots receiving 40 percent less irrigation water than the control plots would dry beyond 0.8 bar. Apparently this did not happen in this trickle-irrigated field. According to Beese et al. (1982), chile plants respond quickly to smaller amounts of water applied by reducing the rate of leaf area development and dry matter production. This decreased development results in smaller plants that consume less water, and in lower soil water tensions at the prevailing rate of irrigation. It also results in reduced yields.

Figure 3 shows the average green chile yield for each of the five water treatments versus the average soil water tension for the period of mid-June through end of August. Soil water tensions were averaged over all depths and all plots within a given treatment. Data in

TABLE 5. Average soil water tensions during the growing season for the 0.6, 0.8, 1.0, 1.2 and 1.4 times control irrigation treatments.

Depth	Irrigation treatment				
(cm)	(0.6)	(0.8)	(1.0)	(1.2)	(1.4)
15	514	391	270	231	164
30	372	266	266	203	121
50	302	242	209	143	60
All depths	396	300	249	192	115

figure 3 show a clear yield response to average soil water tension. These data indicate, for trickle-irrigated chile, the optimum range of soil water tension in the clay loam soil of this study is between 150 and 250 cm. When the average tension drops below this range, yields start to decrease, probably due to lack of oxygen. Above this range, yields decrease due to a slower rate of leaf expansion. This confirms observations by Doorenbos and Kassam (1979) who stated that controlled irrigation is essential for high pepper yields because the crop is sensitive to both over and under-irrigation. These authors further state that, during the most sensitive period, i.e., during beginning of flowering, soil water depletion in the root zone should not exceed 25 percent of the available water. Unpublished data by Saddiq (1983) also showed a singificant increase in crop water stress index for chile peppers when more than 25 percent of the available soil water was taken up, or when the average soil water tension increased above 250 cm H_2O.

Soil salinity

Results of the salinity measurements are presented in some detail in Hibner (1982). Only the major findings will be presented here. Table 6 presents the overall means of electrical conductivity and of the chloride concentrations in the saturation extracts for the years 1976 through 1981. The data in table 6 show that there is no clear trend in the chloride and conductivity values over time. There is significant fluctuation over the years, but there appears to be no strong accumulation of salts in the soil profile. Note, however, that the data in table 6 represent means for all treatments and all soil depths considered. Thus, accumulation of salts can occur in parts of

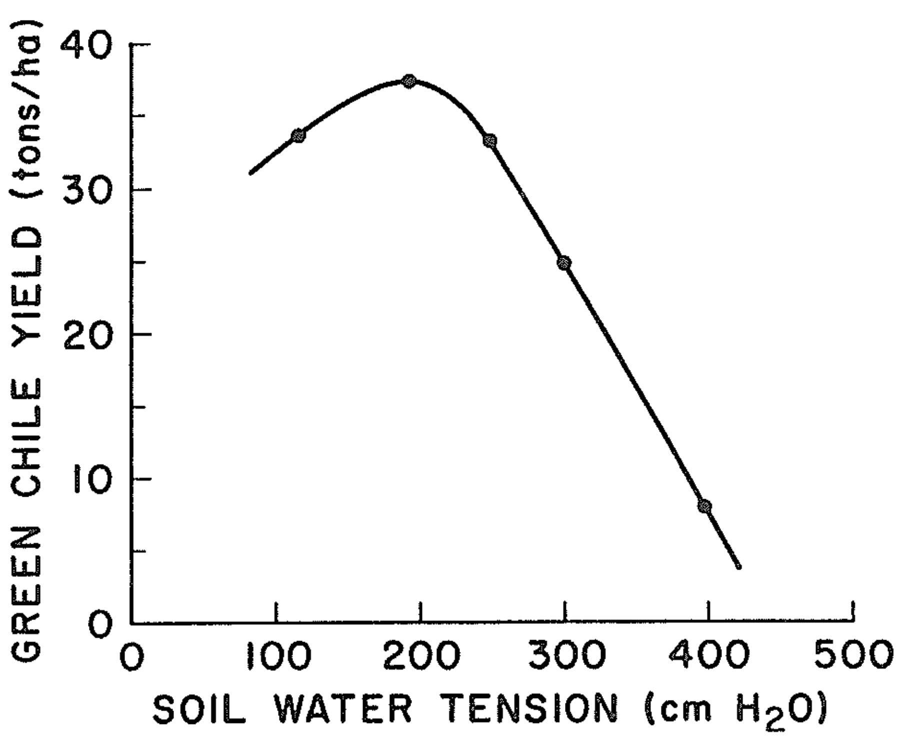

Fig. 3. Average green chile yield versus the mean soil water tension for each treatment over the growing season.

Table 6. General means of electrical conductivity and chloride concentration in the saturation extracted for the period 1976 through 1981.

Year	Chloride meq/l	Conductivity mmhos/cm
1976	7.4	2.5
1977	10.0	3.1
1978	10.7	3.3
1979	9.2	3.3
1980	11.6	2.3
1981	8.9	2.7

the profile during the irrigation season. These salts may be leached out by rain in the summer and winter, or by preirrigation, resulting in relatively stable salinity levels over the years, but in widely varying changes from season to season.

An example of the salt distribution found around at trickle line is presented in figure 4. The numbers in this figure indicate salt concentrations in mmhos/cm of the saturation extracts. The figure shows low salt concentrations around the trickle line where most of the roots are concentrated, and higher salt levels at the top and shoulders of the furrow. This pattern was found to be typical for most of the growing season, except that under the wetter irrigation regimes, the low salt area around the drip line tended to be larger. Furthermore, as the plants grew larger, the salts near the top of the furrow tended to diminish and salts tended to move into the furrows between the plant rows.

Multiyear use of trickle tubing

In 1981, cotton was planted in one-half of a 4-acre field that had been planted in drip irrigated chile in 1980.

The other half also was planted with cotton but was flood irrigated. The chile stalks left from the 1980 growing season were chopped and cotton was planted directly in the untilled soil, without preirrigation. The flood irrigated field was treated as is common in the Mesilla Valley. Assuming there was enough carryover from the 1980 chile crop, no fertilizers were applied to the trickle cotton. Weed control was done with herbicides and some hand hoeing. The total amount of water applied to the cotton through the trickle lines in 1981

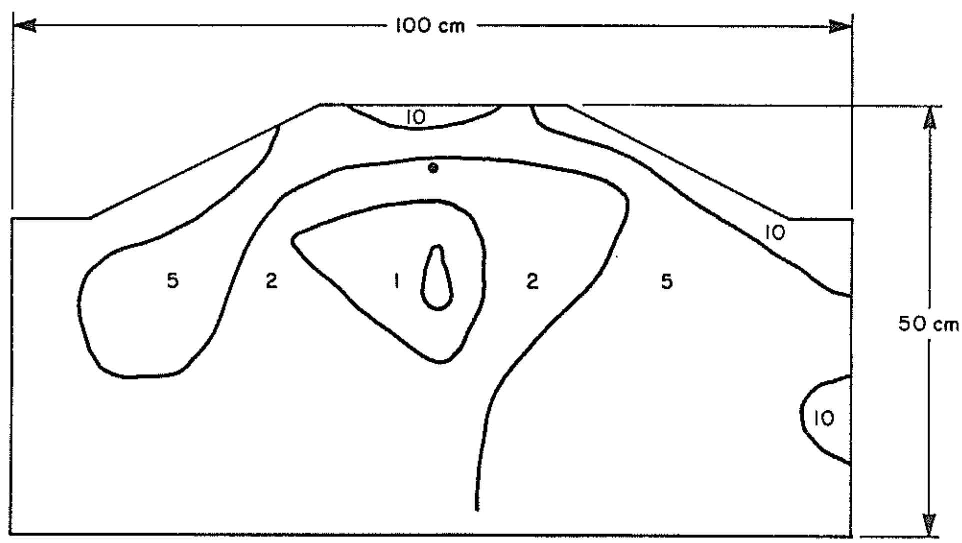

Figure 4. Salt distribution around trickle line on May 27, 1977. The numbers indicate the salt concentration in mmhos/cm. The trickle line is located near the center top of the low salinity area.

was 21 inches. The flood irrigated plot received 31 inches. In 1982, cotton was again planted on the 2-acre trickle irrigated field, using the same tubing, and again without land preparation or cultivation except for chopping of the cotton stalks remaining from the previous season. The amount of water applied to the trickle irrigated cotton in 1982 was 24 inches. Cotton yields in 1981 were 2.2 and 1.9 bales/acre of lint cotton from the trickle irrigated and flood irrigated plots, respectively. In 1982, the cotton yield was 1.4 bales/acre from the trickle irrigated field. Thus, in this three-year non-replicated trial we obtained an excellent yield of chile peppers the first year, an above average yield of cotton the second year, and an average cotton yield the third year. These results show that trickle tubing can be used three years in a row. During the third year, many emitters were plugged and the water distribution over the field was not ideal. Yet an average yield was obtained at minimal costs.

CONCLUSIONS

The main conclusion from this study is that with trickle irrigation high yields of chile peppers can be obtained with moderate amounts of water. We obtained a maximum yield of 37.2 t/ha of green chile in 1981 with 94 cm of water including 13 cm rain water. In general yields increased with water applied up to a maximum yield. Beyond this maximum, yields started to decrease due to lack of aeration as a result of too much irrigation water.

The optimum soil water tension for trickle irrigated chile is around 250 cm H_2O, assuming the soil water tension is measured at 20 to 30 cm below the drip line. This confirms that chile peppers are sensitive to even minor soil water stresses, and that the crop yields suffer from both over- and under-irrigation.

Although there was a seasonal increase in soil salinity near the soil surface, it has been shown that, with trickle irrigation, a relatively salt free zone can be maintained around the trickle line where most of the plant roots are concentrated. Also, the mean soil salinity did not show much of an increase over a five-year period in soil with trickle irrigated chile peppers indicating that, with trickle irrigation, one should be able to maintain low salinity levels in row crops for quite some time.

Multiyear use of low cost trickle tubing seems entirely feasible. It is recommended, however, to bury the tubing at least 7-8 inches deep if use of the tubing for more than one year is desired.

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