SUBSURFACE DRIP IRRIGATION IN COLORADO

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INTRODUCTION

Drip irrigation is becoming increasingly popular in several irrigated production areas in Colorado. As of 2004, there were approximately 2,000 acres devoted to drip irrigation, most of that being permanent systems where the drip tape is buried 6-8 inches below the soil surface. Approximately 90% of the drip-irrigated acreage is being used to grow high-value vegetable crops including cantaloupe, watermelon and onions. This paper will review some of the pros and cons associated with drip irrigation practices in Colorado, as well as issues that effect its future development.

Reasons for Conversion to Drip

In Colorado=s Arkansas Valley, subsurface drip irrigation began to be adopted by commercial growers of cantaloupe in the early 1990's. The primary reason for converting from furrow to drip irrigation was not water savings, but rather improved yield and quality. In most cases, drip irrigation was used in conjunction with plastic mulch. This plasticulture-based production system dramatically improved yield and quality and accelerated crop development thus giving growers access to more lucrative markets. When cantaloupe were cultivated using furrow irrigation with no mulching, cantaloupe yields averaged about 300-400 boxes (12-16,000 lbs) per acre (Colorado Agricultural Statistics,1996). Drip irrigation in combination with plastic mulch nearly doubled that figure for most growers and was even higher under experimental conditions (Table 1). Drip irrigation also made the use of row covers more practical which further advanced the earliness of the crop.

Plasticulture, with drip irrigation as the most critical component, made the production of other vegetables like onions, peppers, and tomatoes more practical. Another notable example of a drip-irrigated specialty crop is seedless watermelon. Seedless watermelons are relatively difficult to grow and seed is extremely expensive. As a result, most seedless watermelons are established as greenhouse-grown transplants. Without drip and plastic mulch, these transplants would have an extremely high mortality rate. Overall, seedless watermelons grown with plasticulture can attain outstanding yields (Table 2).

Table 1: Yield and earliness of Earligold (Hollar Seeds), Gold Rush, and Nitro (Harris Moran) cantaloupe grown with different plasticulture combinations including drip.

Variety and Seeding or Transplanting Date	Row Cover	First Harvest	Average Fruit Size (lbs)	Market. Yield (lbs/acre)
Earligold Transplanted April 23	perforated	July 1	2.97	34,122
Gold Rush Transplanted April 23	perforated	July 5	3.07	42,608
Nitro Transplanted April 23	perforated	July 4	4.32	43,237
Earligold Seeded April 19	perforated	July 8	3.12	44,141
Earligold Transplanted May 6	none	July 8	3.53	55,837
Gold Rush Transplanted May 6	none	July 16	2.92	51,901
Nitro Transplanted May 6	none	July 11	4.43	57,241
Earligold Seeded April 19	none	July 13	3.30	51,062
LSD (0.05)=			0.52	13,155

Table 2. Marketable yield, average fruit weight, and percent stand of seedless watermelon seeded or transplanted into plastic mulches and irrigated via drip.

Establishment Method	Mulch Color	% Stand	Total Average Fruit Weight (lbs)	Total Mkt Yield (lbs/acre)
Seed	Black	50	12.5	34,321
Transplant	Black	100	13.5	51,201
Seed	Green	57	13.0	44,512
Transplant	Green	100	13.0	58,796
Seed	Clear	59	14.1	52,252
Transplant	Clear	100	12.9	55,076
lsd (.05)			1.9	16,431

As drought conditions persisted in Colorado during the 2001-2003 seasons, even more growers adopted drip irrigation. This time the driving forces were not only improved production, but water savings as well. Some of the most dramatic water savings were realized when growing onions. Onions have a extremely shallow root system, with the majority of the roots located in the top 9 inches of soil. Under furrow-irrigated conditions, a typical onion crop could require 14 or more irrigations during the course of the season with a total water application of 7 acre-ft/acre. The vast majority of the total application amount is lost to evaporation, run-off at the end of the field, and deep percolation. In contrast, drip-irrigation application rates have measured about 1.3 acre-ft/acre.

Barriers to Conversion to Drip

Although subsurface drip irrigation has shown tremendous potential in Colorado, there remain sizeable hurdles for wider-scale adoption. The first of these barriers is cost. Most of the drip irrigation systems installed in Colorado cost in the range of $800- $1300 per acre. This huge investment is a hindrance to most growers, particularly those that do not grow high value crops. Although some governmental assistance has been available, it is unlikely that growers of agronomic crops will install drip systems until a higher level of assistance can be offered. Another sizable economic challenge is the need for specialized equipment for installation and tillage.

An additional barrier is the lack of a constant and reliable water supply. Depending on the water right priority, waters originating from surface (river) flows may not be steady and constant. In times of low river flows, some delivery canals may not have access to water for weeks. This characteristic greatly diminishes the yield increase potential attributed to drip irrigation. Well water would be another potential option in Colorado; however, since the Kansas vs. Colorado conflict, well pumping has been greatly curtailed in the Arkansas River Basin and is following suit in other basins.

Future Concerns and Considerations

One of the greatest concerns pertaining to drip irrigation is the ability to secure a constant and reliable water source. Within the constraints of existing Colorado water laws, water saving methods of irrigation like drip are not justly compensated. Given the costly and contentious nature of altering existing water laws, it may prove extremely challenging to foster the future development of drip irrigation in the state.

In some parts of the state particularly the Arkansas Valley, water quality is a concern. The Arkansas River in southeast Colorado is one of the most saline rivers in the United States. Average salinity levels increase from 300 ppm total dissolved solids (TDS) near Pueblo to over 4,000 ppm TDS near the Colorado-Kansas border. More than 200,000 acres along the river are irrigated with Class C4 water, the highest classification for salinity hazard. Most surface waters also contain significant amounts of sediment. Although they lack sediment, ground waters originating from shallow wells are typically even more saline than surface water. It is not clear, if and how salts will accumulate in soils irrigated by drip. Costly maintenance procedures may be needed to ensure that drip systems function properly under poor water quality conditions.

Yet another consideration for Colorado growers is the ability to design a drip system that is able to accommodate a wide variety of crops. Most agronomic crops in the state are produced on a 30 inch row spacing making them amenable to a design containing drip lines spaced 60 inches apart. Although some vegetable crops can be grown with this type of configuration, others, like onions, are not. Since onions are planted in multiple rows per bed and are shallow-rooted, a single drip line placed in the center of the bed at depths greater than 6 inches may not be sufficient to germinate the crop and provide adequate water to the outer rows (Figure 1). In many instances, this design constraint has forced growers to drastically limit their rotation practices and thus, opens the possibility for severe pest problems.

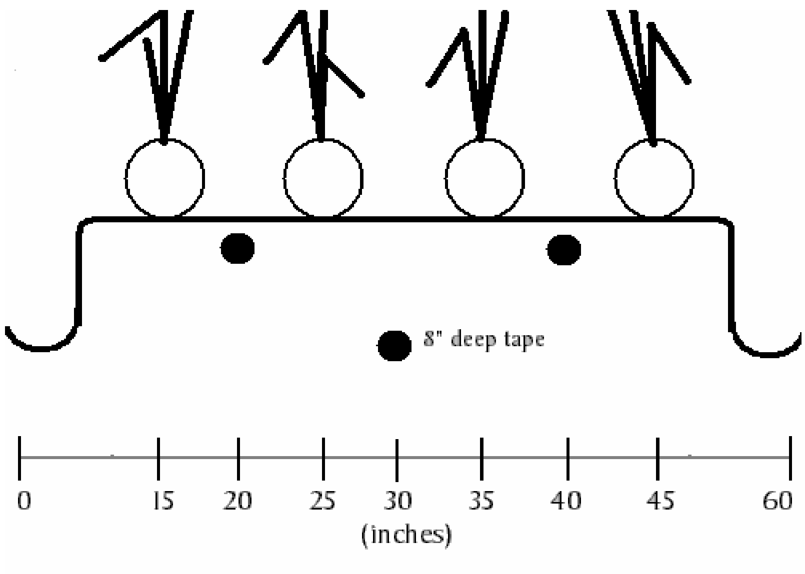

Figure 1: Comparison of drip line placement for onion production; the standard single line placed 8 inches deep in the center of the bed and the more efficient configuration of two lines placed at a shallower depth.

SUMMARY

Drip-irrigation has tremendous potential in Colorado if water law constraints can be ameliorated. As more growers adopt drip irrigation, both research and educational programs will be needed to develop and promote practices that manage the movement of salts in the soil profile and ensure sustainable and profitable cropping patterns.