Vegetable Demonstration Plots: High-Input vs. Low-Input Yield Comparison

Circular 640

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INTRODUCTION

Demand is increasing for locally grown produce throughout the United States as consumers seek fresh, high-quality fruits and vegetables. Many people purchase locally grown produce because reduced shipping requirements support sustainable environmental practices. In addition, consumers justifiably view the purchase of locally grown produce as providing a direct economic benefit to their community (Sayre, 2006).

Consumers patronize locally grown produce in several ways. Farmers' markets, where local growers bring their produce to a centralized site at specific days and times, are a longstanding method (Brown, 2001). New Mexico currently has more than 30 farmers' markets (New Mexico Farmers' Markets, 2008). Truck farms are closely related to farmers' markets; they, however, are so named because farmers have traditionally trucked their harvest to a centralized location for direct-to-customers retail sale. Another method is Community Supported Agriculture (Community Supported Agriculture operations are referred to as CSAs), in which consumers pay a set fee up front and then receive a portion of the harvest (Adam, 2006). Alternatively, there are "U-pick" operations where consumers hand pick their produce. This is a great tool for growers and consumers alike. The consumer can view, select, and freshly harvest the desired produce, while the grower can realize lower production costs due to decreased harvest and shipping needs. All of these operations allow the community to "buy local."

In order to maximize profits, growers need to plant high-yielding varieties of fruits and vegetables in the most cost-effective manner to maximize their operation's efficiency. To run a successful farming operation, both small-scale and larger farming operations must be cognizant of their input costs and returns on their investment. Higher input cost, such as for equipment upgrades, may result in final profits that more than cover expenses.

Drip irrigation is an improved technology that, when correctly managed, may provide optimum watering for crops. Once drip irrigation is installed, plastic mulch, which is incompatible with furrow irrigation, can also be utilized. Plastic mulch can help conserve soil moisture and reduce weed competition in the field. Drip irrigation and plastic mulch are high-input technologies when compared to traditional furrow-irrigated fields. If these higher input technologies lead to higher crop yields and reduction in expenses and time requirements, the initial cost of installation may be justified. This study will help growers determine which setup would best suit their needs in terms of production costs and overall produce yield and income.

MATERIALS AND METHODS

During the 2007 season at New Mexico State University's Los Lunas Agricultural Experimental Station (Valencia County), two paired fields were set up for comparative trials of vegetables. The soil type in both fields was a Gila clay loam. One field was furrow irrigated and considered to be *low-input*. The second, *high-input* field was fitted with equipment for drip irrigation and black plastic mulch. For the trial design, a total of 20 rows were irrigated in each plot (0.33 acre) with the same number of total plants for each crop planted in each field. Pre-plant and pre-soil preparation fertilizer was applied to both plots as follows: 250 lb/acre of 11-52-0 and 250 lb/acre of 0-0-22-22S-11Mg. Urea or URAN (urea plus ammonium nitrate) was injected into the irrigation system of the high-input field eight times during the growing season for a total nitrogen application of approximately 147 lb/acre. In the low-input field, urea was side-dressed on May 31, and URAN was injected into the water on July 30. Total nitrogen application was approximately 153 lb/acre.

Vegetables of the same type, variety, and seed source were planted in both the furrow (low-input) and drip irrigated (high-input) fields so that differences between the two input strategies could be observed. Vegetables were either direct seeded or transplanted into the plots during the optimum planting window. Crops that were direct seeded on the high input side did not have plastic mulch. Direct seeded crops were beets, carrots, green beans, peas, radishes, and spinach. Transplanted crops included artichoke, basil, bell pepper, broccoli, Brussels sprouts, cabbage, chile, cucumber, jalapeño, lettuce, melon, okra, squash, Swiss chard, and tomato (Table 1).

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The high-input design contained 20 rows that were drip irrigated in every row. Plastic mulch and drip tape were laid down on 60-in. centers. Drip-irrigated crops that were grown on 30-in. centers were planted in double rows on each side of the drip tape. The low-input design contained a total of 40 rows that were furrow irrigated every other row. Furrow crops grown on 30-in. centers were planted every row, and furrow crops grown on 60-in. centers were planted every other row. Watering schedule and rate were based on visually gauging plant stress and direct observation of root zone soil moisture. Maintenance records of supply costs, installation and weeding labor, tractor time, fertilizer input, rainfall, and irrigation water inputs were kept daily for both plots. Precipitation over the growing season was 6.3 in. During one rain event in August (that followed an irrigation) much of the chile crop was lost, but with a much higher death rate in the low-input field as compared to the high-input field. The jalapeño peppers were not affected nearly as severely as the other types of peppers. An insecticide (permethrin) was applied once to the broccoli, cabbage, and melons, and twice to the squash crop in both the low- and high-input plots.

Table 1. Crop Type, Variety, and Yield on Both High- and Low-Input Plots

		Yield (lb/plant)	
Crop	**Variety**	**High-Input**	**Low-Input**
Cucumber	Diva	58.3	41.2
Cucumber	Genuine	7.6	5.4
Cucumber	Marketman	24.6	7.8
Squash, Mexican	Magda	22.7	13.0
Squash, Scallop	Patty Green	11.0	3.1
Squash, Yellow	Sebring	16.5	13.9
Squash, Zucchini	Cash Flow	13.2	15.1
Tomato	4th of July	35.1	15.8
Tomato	Brandy Boy	31.4	15.9
Tomato	Celebrity	18.0	18.2
Tomato	Estiva Truss	36.0	18.5
Tomato	Little Mama	30.5	13.9
Tomato	Mountain Spring	17.0	9.4
		Yield per 100 ft.	
Crop	**Variety**	**High-Input**	**Low-Input**
Artichoke	Imperial Star, primary	40 each	26 each
Artichoke	Imperial Star, secondary	98 each	91 each
Basil	Nufar	119.16 lb	78.53 lb
Beet	Early Wonder Tall Top	107 ½-lb bunches	119 ½-lb bunches
Beet	Red Ace	117 ½-lb bunches	35 ½-lb bunches
Broccoli	Buttons	25.4 lb	33.2 lb
Broccoli	Packman	55 heads	74 heads
Brussels Sprouts	Oliver	77.0 lb	116.1 lb
Cabbage	Primax	73 heads	75 heads
Cabbage	Super Red	73 heads	50 heads
Carrot	Hercules	83 1-lb bunches	85 1-lb bunches
Carrot	Yaya	90 1-lb bunches	112 1-lb bunches
Green Bean	EZ Pick	110.8 lb	71.0 lb
Green Bean	Foremost	192.9 lb	64.3 lb
Green Bean	Provider	194.4 lb	57.7 lb
Lettuce	Cherokee	207 heads	193 heads
Lettuce	Nevada	221 heads	189 heads
Lettuce	Tropicana	205 heads	164 heads
Melon	Cantaloupe, Maverick, lrg	39.5 lb	324.6 lb
Melon	Cantaloupe, Maverick, med	363.1 lb	145.0 lb
Melon	Cantaloupe, Maverick, sml	107.0 lb	12.8 lb
Melon	Crenshaw, Lilly	396.5 lb	390.5 lb
Okra	Cajun Delight	245.2 lb	248.0 lb

Table 1 continued. Crop Type, Variety, and Yield on Both High- and Low-Input Plots

		Yield (lb/plant)	
Crop	**Variety**	**High-Input**	**Low-Input**
Pea	Snap, Super Sugar	30.9 lb	21.6 lb
Pea	Snow, Oregon Giant	31.1 lb	27.8 lb
Pepper, Bell	Gourmet	64.3 lb	68.8 lb
Pepper, Bell	King Arthur	227.3 lb	127.3 lb
Pepper, Bell	Sun Ray	52.3 lb	76.8 lb
Pepper, Bell	Sweet Chocolate	36.6 lb	67.9 lb
Pepper, Chile	Arizona 411	78.5 lb	49.0 lb
Pepper, Chile	Big Jim	87.1 lb	55.4 lb
Pepper, Chile	Española Improved	65.4 lb	21.9 lb
Pepper, Chile	NM21 (Sichler's Selection)	62.4 lb	59.7 lb
Pepper, Chile, Dried Red	Arizona 411	4.2 lb	10.8 lb
Pepper, Chile, Dried Red	Big Jim	0.9 lb	1.5 lb
Pepper, Chile, Dried Red	Española Improved	12.0 lb	4.0 lb
Pepper, Chile, Dried Red	NM21 (Sichler's Selection)	9.4 lb	2.3 lb
Pepper, Italian Sweet	Corno di Toro	112.0 lb	43.8 lb
Pepper, Jalapeño	Delicias	196.5 lb	139.0 lb
Pepper, Jalapeño	El Jefe	263.4 lb	329.0 lb
Radish	Cherriette	209 6-oz bunches	272 6-oz bunches
Radish	D'Avignon	288 6-oz bunches	188 6-oz bunches
Spinach	Lombardia	19.6 lb	13.6 lb
Spinach	Remington	16.3 lb	12.5 lb
Swiss Chard	Fordhook Giant	203.2 lb	95.9 lb
Swiss Chard	Ruby Red	110.3 lb	44.0 lb

INCOME

In addition to reporting yield, anticipated income per 100 ft of row for each vegetable was also determined (Table 2). Most of the harvested fruits and vegetables were sold at the local farmers' market at $1 per pound for ease in record keeping. However, the market value would be expected to be much higher for much of the produce. Overall, there was an estimated increase in gross income for the high-input plot over the low-input plot (Table 2).

RESULTS AND DISCUSSION

Initially, the high-input system had a much higher price for setup (Table 3). However, throughout the project, the high-input system required less irrigation water (Table 4) and less time and labor for weeding (Table 5). The high-input system generally showed higher yields per 100-ft row of plants. In each plot, 52 different varieties of fruits and vegetables were grown, and over 66% of those showed greater yields in the high-input plot. Contrastingly, the crops grown in the low-input plot showed higher yields in only 33% of the varieties. Consequently, the high-input system had a much higher estimated gross income than the low-input system. This does not include the costs for labor, machinery, fertilizer, and water use, which will vary by location and must be determined by each individual operation.

Water use was drastically different between the two plots. In the high-input plot, the amount of water applied during the season was 12 ac-in., which is in stark contrast to the 39 ac-in. used on the low-input plot. This difference shows how the drip system in the high-input plot used water more efficiently and effectively than the furrow irrigation method used in the low-input plot. Both plots utilized the tractor equipment approximately the same amount of time over the season; however, the high-input system did require more labor hours to install and remove the plastic mulch from the plot (Table 6).

Overall, the high-input system saved time, energy, and money. Despite the increase in costs and labor to install the drip irrigation system and the mulch, this initial investment lead to significant time saved in weeding and less waste of resources such as water.

RECOMMENDATIONS TO PRODUCERS

In deciding between a drip irrigation system and traditional furrow irrigation, producers should take into account starting costs, water availability, variety of vegetables being produced, and availability of labor at different times in the season. Overall, this study suggests that water use and labor time can be reduced under a high-input system using drip irrigation and plastic mulch. However, the producer must plan to invest resources (time/labor and money) at the beginning of the season to recognize these savings at the end of the season. Producers should also carefully consider their product and their production goals. For example, in this study, overall weight of cantaloupe (Maverick variety) was slightly greater under the high-input scenario than the low-input scenario. However, production of large cantaloupe was much greater under the low-input, furrow-irrigation scenario. This has different implications depending on whether a producer is supplying a market that demands large cantaloupe or one that accepts cantaloupe of varying sizes. In this study, yields under the high-input system decreased in the production of some cool-weather crops, such as broccoli and Brussels sprouts (though inputs of water and labor were still less in the high-input system). Generally, decreased production of cool-season crops using drip irrigation and plastic mulch may be due to higher soil temperature in mid-summer under plastic mulch. Chile, despite being a warm-season crop, also realized higher red chile yields in the low-input system. These results may be misleading, however. The green chile crop experienced high losses in the low-input plot due to root rot. While this reduced the green chile harvested from the low-input plot, dry red chile was still harvested from the dead plants, which inflated the low-input red yield. Without the disease pressure, red chile yields under low-input would likely not have been as great.

Growers should carefully consider every variable in their production situation in order to ensure the most successful investment in their operation. In any case, production goals should be balanced against the cost and availability of inputs.

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Table 2. Estimated Gross Income Based on 100-ft Row of Each Crop for Both High- and Low-Input Plots

High-input	$22,647.00
Low-input	$14,945.00

Table 3. Costs for Drip Irrigation Equipment and Plastic Mulch Installations for Both Plots, Not Including Tractor Equipment

High-input	$365
Low-input	$0

Table 4. Amount of Irrigation Water Applied Over the Course of the Season for Both Plots

High-input	12 ac-in.
Low-input	39 ac-in.

Table 5. Number of Labor Hours Needed for Weeding for Both Plots

High-input	14.75 hrs
Low-input	46.25 hrs

Table 6. Number of Equipment and Labor Hours Needed for Installation and Removal for Both Plots

High-input	
Tractor	5.50 hrs
Labor	23.50 hrs
Low-input	
Tractor	5.25 hrs
Labor	12.75 hrs

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