Water Reduction Methods for Strawberry Irrigation

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Abstract

We took a look at the irrigation methods of strawberry farmers in the Pajaro Valley and ways that they could reduce the amount of water that it takes to produce their strawberries. In many areas the limited amount of water is effecting the production of crops. We believed that in an area that was already practicing the “best” irrigation method of using drip that we could still find inefficiencies and reduce the amount of water they use. The use of sprinklers during the first couple of weeks seemed like an obvious place to start with reducing the water used. By analyzing the first couple of weeks we found a number of gallons that could be saved. By reducing the amount of water used by simply switching to drip during the first couple of weeks. There was no evidence that the sprinklers during the first couple of weeks actually improved the success.

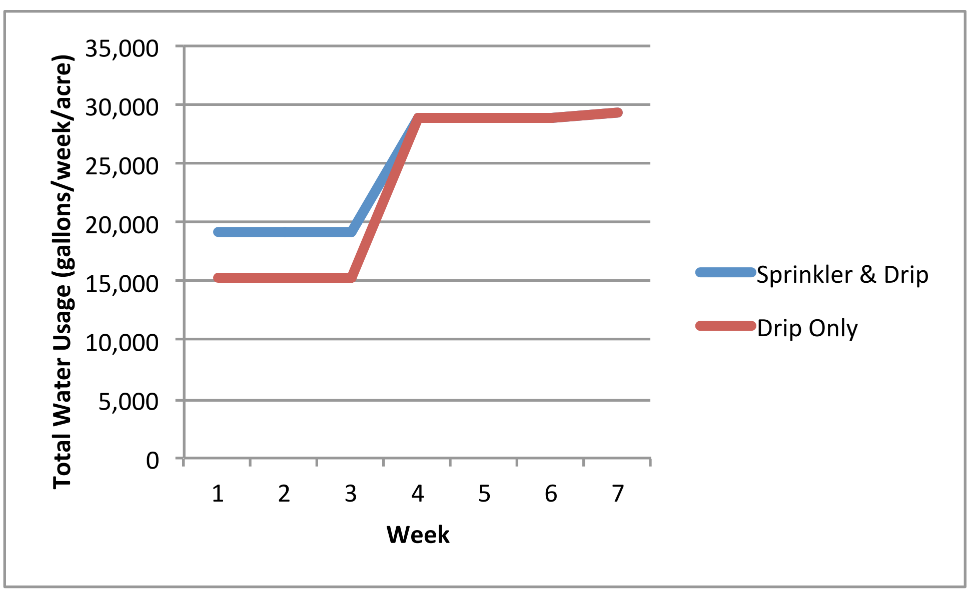

Figure 1

Fig. 2: Watering Schedule for strawberries

Note: week 7 is actually the next 24 weeks but the value stays the same so we compressed it to make the graph more visible

Creation: Moore, Thomas (2012)

Source: Solis, Samuel. 2012

Introduction

Our group decided to look at the water usage for strawberry farmers. With California producing 80% of the nations strawberries and the Central Valley producing 80% of California's total (3). We decided to focus our study on the Pajaro Valley. Currently the valley is faced with two large problems, adjudication and salt water intrusion, related to their water supply.

Objective

Our objective for this project addresses the issue of water conservation in Pajaro Valley by implementing more efficient irrigation techniques. In order to achieve this goal, our project was broken down to two parts: (a) consolidation of irrigation data and analysis of quantity water saved per alternative irrigation techniques (b) formulation of both a short-term and long-term proposal to the farmers of Pajaro Valley though analysis of the data collected. Two separate proposals analysis would take into consideration the feasibility and optimization of the chosen alternative.

Our project would focus on the early growth stage period immediately after breaking dormancy. (Fig. 2). Notice, during the early stages, the crop coefficient values period of 0% to 10%, there is minimal change in value of Kc= 0.01 (Fig. 3). Our project's primary focus address improving water conservation efficiency during the early growth stage period after plant transplantation. The basis of our project relies on the cognition that strawberry crops requires less water to establish than what is currently applied. The product data would then be used in conjunction with our analysis of alternative methods to help irrigation managers plan when irrigation should occur and how much water should be replenished into the soil.

Hypothesis

We hypothesized that the amount of water applied to strawberry plants exceeds the amount of water they need to sufficiently grow and produce fruit. In addition, we hypothesized that drip irrigation alone is sufficient for providing enough water to the strawberry plants, eliminating the need of sprinkler irrigation.

Data Sources

(4) Black, B. (2008). “Strawberry Irrigation.” Utah State University Cooperative Extension, Logan, Utah.

(8) Samuel Solis, personal communication in person and by email, November 16, 2012

Methods and Assumption

We wanted to know how much water can be saved by switching from sprinkler irrigation to drip irrigation by strawberry farmers who are located in the Pajaro Valley.

- We started by calculating how much water is used to irrigate strawberries using sprinkler irrigation (gal/acre) during the first 3 weeks after tranplanting. Data was obtained from the water schedule of one farmer provided by Professor Sandoval (Sandoval 2012).

**Assumption: We generalized this water schedule to be the regular schedule for all the farmers in the Pajaro Valley.

- gal/acre was converted to acre ft

-7000 acres of strawberry (rough estimation of the actual number) was multiplied to the acre ft value to obtain how much water was used for all strawberry farmers. **assumption:

*all farmers used sprinkler irrigation only following transplanting.

*all farmers followed the same water irrigation schedule as was provided by Professor Sandoval.

*all farmers planted strawberries during the same season.

- The value above was the amount used for one week. We took this value and multiplied it by 3 weeks to get the amount of water used for all farms for 3 weeks using sprinkler irrigation. **assumption: That all farmers in the Pajaro Valley used sprinkler for three weeks only.

- We converted the above amount to an amount using drip irrigation, which was 20% more efficient (Black 2008). **Assumption here is that the efficiency was exactly 20%.

Calculation/Results

(1 acre)(19,200 gal/acre)/(325,851 gal/acre ft)= 0.058922 acre ft*

(0.058922 acre ft/acre) (7,000 acres)= 412.458 acre ft*

*412.458 acre ft * 3 (weeks)= 1237.37 acre ft*

*1237.37 acre ft * 0.20= 247.475 acre ft saved*

OR

(19,200 gal/acre)(0.20)*(7,000 acres)*(3 weeks) =80,640,000 gallons saved*

Conclusions

Our hypothesis was supported as the analysis and calculations we performed in this project indicate that drip irrigation alone is suitable for establishment, growth and fruit production of strawberry plants. Sprinkler irrigation, which is usually applied in addition to the drip irrigation, provides excess water to the plants. This excess water is not utilized by the plants and it most likely becomes runoff.

The main findings of our project indicate that most strawberry farmers in Pajaro Valley are using both sprinklers and drip irrigation in their farming practices. Farmers mainly use sprinklers in the first few weeks of the plants being planted, this is practice is based on the believe that the plants need more water for their establishment. However, we were not able to obtain any information on the increased success of root establishment and the water available. In fact, due to the low crop coefficient in the beginning of the plant's life, we believe the plant needs less water to establish than what is currently applied.

We also found that through a simple elimination of sprinkler irrigation use the farmers can save about 247 acre feet of water in a planting season. This water will be mainly saved from the first three weeks of the plants being irrigated. Strawberries are one of the main crops produced in Pajaro Valley. Application of more water than necessary for these plant threatens the availability of water for other crops grown in this area. Today

Pajaro Valley faces several serious water problems, such as salt water intrusion due to overdraft of groundwater.

As water in the State of California is limiting resource, there have to be irrigation efficiency methods implemented, in order to avoid depleting the water resource completely. Reduction in water demand for strawberries in Pajaro Valley will help in the overall water problem in California.

Recommendation/Limitations

Switch to only drip

Our analysis concluded that switching from using drip and sprinkler irrigation to only drip irrigation will save farmers decent amount of water per planting season. Therefore, we suggest that farmers in Pajaro Valley growing strawberries, should switch their irrigation to solely drip irrigation, and eliminate using sprinklers.This change of irrigation systems can be implemented immediately as it will not require large change in the current practices of the farms. They could take the drip irrigation a step further to increase efficiency and potentially save even more water and money in the long run. This step further will include updates of their management of their already existing drip irrigation system. They can hire a company that can measure the soil tension. These companies usually provide tensiometers and labor for monitoring these tensiometers. On average the expense of hiring a company that provides these services is about $199 per month per acre (Otto 2012). Using these tensiometers will inform farmers on when they need and when they do not need to apply water to their crop, allowing them to prevent unnecessary water application and save water.

In addition to the immediate applicable switch from drip and sprinkler irrigation to only drip irrigation, our group researched some possible future alternatives. The alternatives that we propose here are large scale updates to the irrigation and farming practices of farms in Pajaro Valley. These alternatives will likely require a large upfront investment, but will potentially increase largely the water use efficiency of the farms. We mainly examined three alternatives: vertical farming, plugs (crop transplants) and computer automated monitoring system.

Vertical Farming

Vertical farming is farming in closed system, usually tall buildings. According to Dr. Despommier this system will allow for recycling of all the water used for irrigation, by collecting the water of evapotranspiration, and it will eliminate runoff (The Economist 2010). Recycling of water will reduce drastically the amount needed to grow crops. If this systems are installed in California, they will allow reduction of the water demand and will help solving the water problem in the long run. In addition, the closed system will allow for controlled temperature and humidity levels that will produce the ultimate yield.

Some additional advantages of vertical farming include crop production year round, prevention of pest outbreaks and pesticide application.

Nowadays, many of the fruits and vegetables californians consume have to travel large distances between the farmer and the consumer, resulting in large amounts of carbon emissions. Vertical farms are often planned to be built in urban areas, shortening the distance between the farmer and the final consumer. This proximity between the producer and consumer will “dramatically reduce fossil fuel use (no tractors, plows, shipping)” (Despommier 2012).

However, there are a few disadvantages to implementing vertical farming. First, the amount of money that has to be invested in building the structure and equipment will be very large. It is unlikely that farming families and individuals will be able to afford building their own vertical farm.

Second, if the farms are built in the center of urban areas that will change the people being employed by the farming industry. The vertical farms may require more people to maintain them, but they will mainly be people from the city, leaving farmers without jobs. Lastly, if the vertical farms are kept as closed systems, pollinators will not be able to reach the plants and pollinate them, therefore all pollination will have to be done by hand (Whitney 2010).

Plugs (crop transplants)

Another alternative that we suggest in this study are plugs or also called plant transplants, plants that are raised in containers until they can be transplanted in the field. In the case of strawberries these plugs are usually plants that have well established root ball, so when they are transplanted into the field they do not need much time and water to establish their roots. In fact, once the plugs are transplanted they only need one overhead watering (Allens Creek Farms 2011). Through only applying overhead watering once farmers can save a lot of water and money. In addition, plugs tend to produce higher yield and in some cases it is produced earlier in the year.

A disadvantage that our group found in connection to plugs is that they can cost twice as much as bare root transplants. As they will be better established plants at the time the farmers purchase them, it is likely they will be more expensive than bare root transplants.

Computer Automated Monitoring System

The last alternative that our group proposes is computer automated monitoring system. The new development of computerized monitoring system is a new technological engineered system that is designed to streamline farmer's irrigation management. This new innovative irrigation system consists typically of:

-A wireless field monitoring station containing on-site field sensors that can measure soil tension, hydric stress, temperature, and humidity

-A communication station that can transmit and process wireless onsite data to other networks

-A field control unit that allows remote access to irrigation functions. Jeremy Otto from Hortau, computerized monitoring company, quoted the estimated cost for one monitoring station per acre cost roughly $4200/ acre with a $85/ month service charge (2012).

Computer automated monitoring systems can allows for streamline management of multiple irrigation areas though simple computerized display. Data provided by onsite sensors can allow for maximum control of irrigation frequency and watering durations to keep soil tension in comfort zones. This process is simple to use and require minimal effort. This system would also allow the ability to achieve greater water, energy, and fertilizer efficiencies.The drawback of this system is the high cost due to expensive equipment cost, along with the potential loss of jobs due to soil monitoring workers replaced with mechanical counterparts.

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(3) Bertelson, D. (1995). “ The U.S Strawberry Industry.” Report Statistical Bulletin Number 914, U.S Department of Agriculture, Washington D.C.

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<http://www.verticalfarm.com/more>. (Nov.27, 2012).

(6) Jeremy Otto, personal communication by email, November 26, 2012.

(7) Jeremy Otto. Personal phone interview. November 26, 2012.

(8) Samuel Solis, personal communication in person and by email, November 16, 2012

(9) The Economist (2010) “Vertical Farming: Does it really stack up?”

<http://www.economist.com/node/17647627>. (Nov. 29, 2012)

(10) Whitney, O. (2010). “Vertical Farming, the Pros and Cons.” <http://verticalharvest.wordpress.com/2010/09/15/vertical-farming-the-pros-and-cons/>. (Nov. 25, 2012).

Figures

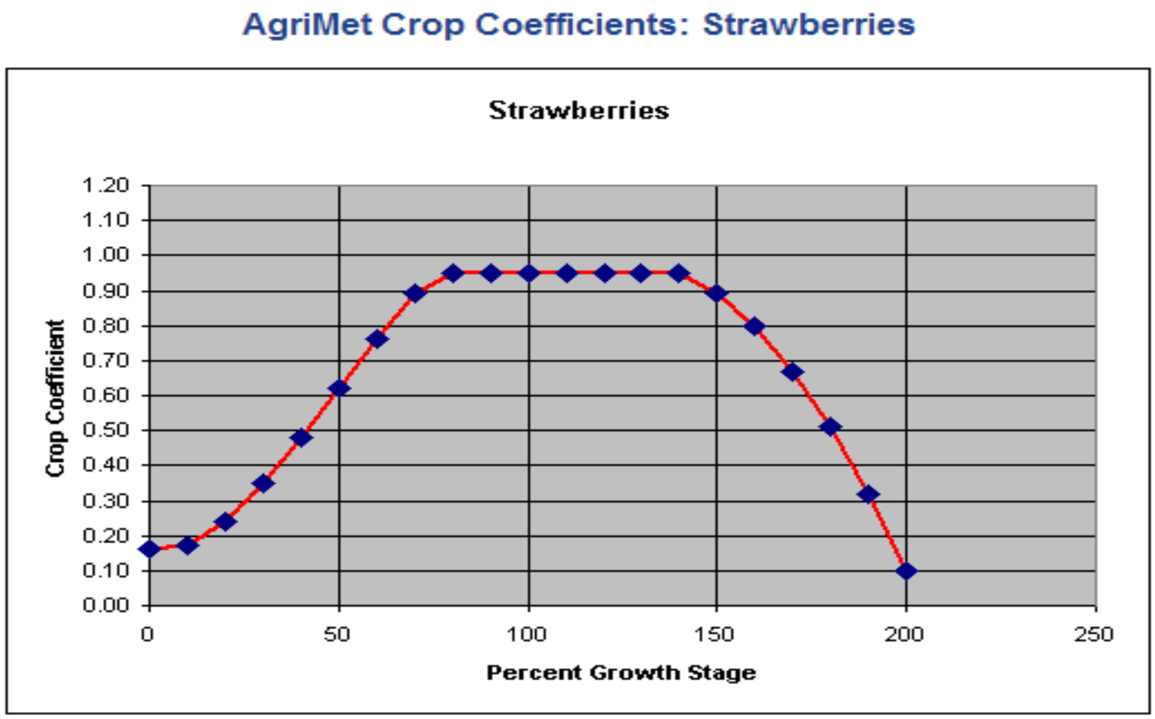

Fig. 2: Generalization of Pajaro Valley strawberry crop coefficients (Kc)

Note: The low crop coefficient values and stagnant change in slope during the early growth period.

Creation: Moore, Thomas (2012)

Source: Solis, Samuel. 2012

Growth Stage (%)	Crop Coefficient	Growth Stage Indicators
0	0.16	Break Dormancy
10	0.17	
20	0.24	
30	0.35	
40	0.48	
50	0.62	
60	0.76	
70	0.89	
80	0.95	
90	0.95	
100	0.95	Full Bloom
110	0.95	
120	0.95	
130	0.95	
140	0.95	
150	0.89	
160	0.80	
170	0.67	
180	0.51	
190	0.32	
200	0.10	Killing Frost

Curve developed by USBR, Mid-Pacific Region, 1975.

Fig. 3: Strawberry crop coefficient data table

Note: Low Kc values during the early growth stage (%).

Source: USBR, Mid-Pacific Region, 1975