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Managing Existing Sprinkler Irrigation Systems

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INTRODUCTION

The California State Water Code requires anyone discharging waste that could affect the waters of the state to obtain a permit or coverage under a waiver. Agricultural runoff, whether from irrigation or rainfall, that leaves a property has been determined to likely contain waste (sediment, nutrients, chemicals, etc.).

Compliance under the Irrigated Lands Conditional Waiver is available to agricultural landowners who have runoff from their property caused by irrigation practices or winter rainfall. The California Water Code does not impact the property owner if no runoff from any source leaves a property.

If runoff does occur from an existing sprinkler-irrigated orchard, the runoff amount may be reduced by changing the design and setup of sprinkler system, changing the management of the sprinkler system, or changing the management of the orchard floor.

CHANGING THE DESIGN AND SETUP OF THE SPRINKLER SYSTEM

If the sprinkler application rate exceeds the intake rate of the orchard soil, runoff will occur. The sprinkler application rate is influenced by the discharge rate of the sprinkler heads and the sprinkler spacing (see *Soil Intake Rates and Application Rates in Sprinkler-Irrigated Orchards*, ANR Publication 8216). Reducing the sprinkler head discharge rate or increasing the distance between sprinkler heads decreases the application rate. Runoff can also be greater in sprinkler systems with poor irrigation uniformity since some irrigated areas receive greater amounts of water than others.

Changing the sprinkler spacing in an existing orchard is seldom practical. The mainline, submains, and lateral lines are buried, so changes may be extremely time-consuming and costly. Changing the discharge rate of the sprinkler heads may, however, be feasible.

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The discharge rate of a sprinkler head is determined by the size of the sprinkler nozzle (see fig. 1) and the operating pressure (see table 1). Reducing the operating pressure of the sprinklers reduces the sprinkler discharge rate. Referring to table 1, note that for a particular nozzle size, the discharge rate is not significantly changed by small changes in operating pressure. For example, reducing the operating pressure from 50 to 45 psi (a 10 percent change) decreases the application rate by less than 5 percent. Large changes in operating pressure, such as 10 psi or greater, would therefore be needed to significantly impact the application rate.

Figure 1. Close-up of an impact sprinkler head with the nozzle and orifice size (7/16) stamped on the nozzle. *Photo:* Lawrence J. Schwankl.

Caution should be taken in reducing the sprinkler operating pressure since it can negatively affect the sprinkler application uniformity. Operating a sprinkler below its recommended pressure range (often provided by the manufacturer) may result in unacceptable breakup of the sprinkler spray pattern and poor irrigation uniformity. High application uniformity is desirable since it helps ensure that all areas receive the same amount of water. This allows efficient irrigation without underirrigating or overirrigation any location in the orchard.

Table 1. Sprinkler discharge (gpm) for various nozzle sizes (in) and pressures (psi).

psi	Nozzle size (in)										
	3/32	7/64	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4
20	1.17	1.60	2.09	2.65	3.26	3.92	4.69	5.51	6.37	7.32	8.34
25	1.31	1.78	2.34	2.96	3.64	4.38	5.25	6.16	7.13	8.19	9.32
30	1.44	1.95	2.56	3.26	4.01	4.83	5.75	6.80	7.86	8.97	10.21
35	1.55	2.11	2.77	3.50	4.31	5.18	6.21	7.30	8.43	9.69	11.03
40	1.66	2.26	2.96	3.74	4.61	5.54	6.64	7.80	9.02	10.35	11.79
45	1.76	2.39	3.13	3.99	4.91	5.91	7.03	8.30	9.60	10.99	12.50
50	1.85	2.52	3.30	4.18	5.15	6.19	7.41	8.71	10.10	11.58	13.18
55	1.94	2.64	3.46	4.37	5.39	6.48	7.77	9.12	10.50	12.15	13.82
60	2.03	2.76	3.62	4.50	5.65	6.80	8.12	9.56	11.05	12.68	14.44
65	2.11	2.88	3.77	4.76	5.87	7.06	8.45	9.92	11.45	13.21	15.03
70	2.19	2.99	3.91	4.96	6.10	7.34	8.78	10.32	11.95	13.70	15.59
75	2.27	3.09	4.05	5.12	6.30	7.58	9.08	10.66	12.32	14.19	16.14

Note: Metric conversions: 1 inch = 2.54 cm; 1 ft = 0.305 m; 1 gallon = 3.79 l; 1 psi = 6.89 kPa or kNm^2.

As an alternative to reducing pressure, the sprinkler application rate can be reduced by using a smaller nozzle. The existing sprinkler application rate can be determined using the following formula. Note that the sprinkler application rate is directly proportional to the nozzle discharge rate.

Sprinkler application discharge rate (gpm) = [96.3 × Nozzle rate (in/hr)] ÷ [Sprinkler spacing (ft) × Tree spacing in the tree row (ft)]

Reducing the sprinkler nozzle size may be an alternative for reducing the application rate. For example, changing the sprinkler nozzles from 7/64 inch to 3/32 inch on a 40-psi sprinkler system with a 20- by 48-foot spacing reduces the application rate from 0.23 inches per hour to 0.17 inches per hour, a 26 percent decrease.

There are two cautions when doing this. First, due to the characteristics of pumps, reducing sprinkler discharge rates may result in an increase in operating pressure. This would negate some of the benefit of decreasing the application rate. Second, reducing the application rate requires additional irrigation set time (or more frequent irrigations) to apply the same amount of water to the trees. If the orchard was irrigated properly before the retrofit to smaller nozzles, maintaining the same set times and irrigation intervals will underirrigate the trees.

CHANGING IRRIGATION MANAGEMENT

A change in irrigation set times (duration and frequency) may be effective in reducing runoff. Reducing set times requires more frequent irrigations to adequately irrigate the orchard. Under some orchard conditions, reducing irrigation set times may reduce runoff if the irrigation ends before the irrigation system application rate exceeds the soil infiltration rate. Typically, the infiltration rate starts high and decreases with time until a final, constant infiltration rate is achieved (for more information, see *Soil Intake Rates and Sprinkler Application Rates in Sprinkler-Irrigated Orchards,* ANR Publication 8216). For example, a standard practice of one 24-hour irrigation set every 2 weeks may result in unacceptable runoff, but two 12-hour sets spaced 1 week apart may produce less runoff. This irrigation water management practice requires no physical changes to the irrigation system or changes in orchard floor management, so it can be easily “field tested” to see whether it is effective.

Figure 2. Cover crop in an orchard. *Photo:* Lawrence J. Schwankl.

Figure 3. Spring tooth harrow breaking up the soil surface in an orchard. *Photo:* Terry L. Prichard

CHANGES IN ORCHARD FLOOR MANAGEMENT

The use of cover crops or mechanical tillage can increase the water intake rate and decrease the runoff rate in an orchard.

Cover crops (fig. 2) can reduce runoff in three ways. First, they can protect the soil from the detrimental effect of water droplets impacting the soil (water droplet impacts cause fine soil particles to form a crust on the soil surface, reducing the soil's intake rate). Second, cover crops keep the soil more permeable, increasing the intake rate. Experience has shown, however, that a cover crop may increase the soil's initial infiltration rate but have little effect on the final infiltration rate. Since sprinkler systems are usually designed to apply water based on the final infiltration rate, runoff may not be reduced. Third, cover crops can physically impede water runoff. Because water does not move quickly across a cover-cropped soil surface, there is more time for water to infiltrate the soil.

A caution in the use of cover crops is that they require additional water. It is expected that an orchard with a growing cover crop will use as much as 30 percent more water than a comparable orchard without a cover crop.

Mechanical disturbance of the soil surface using a spring tooth harrow (fig. 3) or similar device can also increase the water intake rate of the orchard. A thin crust on the soil surface that can seal the soil surface and reduce infiltration may develop as a result of sprinkler irrigations, and breaking this crust may improve the intake rate. Depending on the soil conditions, the crust may reform, and the benefit of breaking up the crust may be short-lived. Applying gypsum may be effective in improving infiltration when using irrigation water with a low level of electrical conductivity (EC) and a high sodium adsorption ratio (SAR).

RUNOFF OCCURS NO MATTER WHAT YOU TRY

If significant runoff occurs even with changes in the operation and management of the irrigation system and orchard floor, the runoff water should be collected and reused. Tailwater collection systems with storage ponds are common in flood-irrigated row and field crops, but they are not common in sprinkler-irrigated orchards, yet their use is feasible in orchards. If a storage pond is used, a system should be in place to reuse the collected water for irrigation. For more information on tailwater return systems, see *Tailwater Return Systems* (ANR Publication 8225).

If the runoff amounts are not significant, it may be feasible to seal the ends and edges of the orchard with small berms to retain the water in the orchard.

FOR FURTHER INFORMATION

Storing Runoff from Winter Rains (ANR Publication 8211), 2007.

Understanding Your Orchard's Water Requirements (ANR Publication 8212), 2007.

Measuring Irrigation Flows in a Pipeline (ANR Publication 8213), 2007.

Causes and Management of Runoff from Surface Irrigation in Orchards (ANR Publication 8214), 2007.

Soil Intake Rates and Application Rates in Sprinkler-Irrigated Orchards (ANR Publication 8216), 2007.

Tailwater Return Systems (ANR Publication 8225), 2007.

Measuring Applied Water in Surface Irrigation (ANR Publication 8226) [in process].

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