EFFECT OF SCHEDULING OF IRRIGATION OF ORCHARDS ON WATER & LABOUR REQUIREMENTS

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INTRODUCTION

The general procedure used in the scheduling of irrigation of orchards in the Okanagan Valley has already been outlined (1, 3). The first steps were to determine the safe irrigation interval in the heat of the summer and the amount of water required at each irrigation. Two evaporimeter assemblies and a rain gauge were established at or near each orchard. Evaporation was transposed daily into irrigation deficit in inches, and the soil moisture balance-sheet method was used for determining when to start each irrigation. Except perhaps in the heat of the summer, there was a period between irrigations when water was not applied.

One of the main purposes of scheduling is to save water and labor. The question is, how effectvely does scheduling actually accomplish this? It is the purpose of this paper to answer this question on the basis of four years' experience in which 17 growers scheduled their irrigation by the balance-sheet method.

EXPERIMENTAL PROCEDURE

The percentage of time during which the sprinkler lines lay idle was considered to represent the percentage of savings in water and labor as compared with steady irrigation. The time saved was calculated in two ways: first, the time during which the lines would have lain idle if the grower had had barely enough equipment to irrigate within the safe irrigation interval in the heat of the summer; and second, the actual time that the sprinkler lines were not in use. The difference between these two was caused by the fact that some growers had enough sprinklers to complete an irrigation more quickly than necessary. Throughout any one irrigation season, the same amount of water was applied at each irrigation in any one orchard.

Scheduling was conducted on 17 orchards for four years, 1962 to 1965 inclusive. These orchards were located in the Summerland and Oliver-Osoyoos districts. All were irrigated by the sprinkler method with portable aluminum pipes. A technician kept a balance sheet for each orchard from daily rainfall and evaporation records obtained at each orchard. Each grower commenced each irrigation according to the balance-sheet procedure, completed the irrigation, then discontinued irrigating until it was time to start again (1). During the four years, minor changes were made in the safe irrigation interval and in the amount of water applied at each irrigation, and major changes were made in the ratio of irrigation requirement to evaporation and in the balance-sheet procedure. Each change was made with the ultimate purpose of applying the least amount of water necessary without running the risk of encountering soil moisture deficits great enough to reduce tree growth or yield.

Few growers irrigate continuously throughout the season. Comparing the number of days of irrigation while scheduling with the total number of days in the irrigation season, therefore, may not respresent accurately the actual savings in time and water by scheduling. In an attempt to adjust for so-called "normal" use of water by growers who are not scheduling, a study was made of the Oliver-Osoyoos area as a whole. Records of the Southern Okanagan Lands Project were examined to determine the percentage of peak flow that was being used in the Oliver-Osoyoos area during each part of the season. The same was also done with each of the 17 orchards under test.

RESULTS

Effects of Soil Texture on Number of Days of Irrigation

As a measure of soil texture, the safe irrigation interval in the heat of the summer was used. This interval varied from 4½ days with a sand to 28 days with a fine silt loam. The safe interval was correlated with the number of days of irrigation during the season, obtained by multiplying the safe interval in days by the number of irrigations. The coefficients of correlation obtained on 17 orchards were as follows:

1962	—0.531
1963	—0.494
1964	—0.263
1965	+0.302

Required for significance ($P = 0.05$) was a coefficient of 0.482. Thus in 1962 and 1963 the finer the soil texture, the less was the time spent in irrigating. Unusual weather conditions, however, upset this relationship in 1964 and 1965. A dry September caused all growers to apply one extra irrigation, which meant a high percentage of increase on top of the two or three irrigations on the silt loam soils during the season, and a much lower percentage of increase on top of the 15 or more irrigations on the sandy soils.

Savings n Water and Time as Compared with Steady Irrigation

These savings have been calculated by first determining the percentage of time irrigating, then deducting this from 100%. The former was determined by two methods:

$$\%\ \text{time irrigating} = \frac{100\ (\text{safe interval x No. of irrigations})}{\text{No. of days in irrigation season}} \qquad (1)$$

$$\%\ \text{time irrigating} = \frac{100\ (\text{No. of days irrigating})}{\text{No. of days in irrigation season})} \qquad (2)$$

The difference between these two formulas is due to the fact that some growers had enough sprinklers to irrigate in less time than the safe interval. The number of days in the irrigation season was considered to be the time between the start of the first irrigation and the end of the last irrigation.

The water and operating time saved by scheduling varied widely from year to year (table 1). The increase in savings in 1964 and 1965 can be attributed in part to increasing accuracy in use of the scheduling procedure and in part to cooler weather during most of the season. The values shown in table 1 are averages for the 17 orchards.

Savings in Water and Time as Compared with Actual Grower Practice

Some growers stop irrigating for a while during wet or cool weather even when not scheduling. The actual savings in water and time should, therefore, be lower than those indicated in table 1, especially in a cool season.

As a preliminary step in scheduling, the irrigation equipment was re-designed in some orchards at the start of the experiment, and in some cases smaller nozzles were used. This, however, was usually offset by use of more sprinklers. The average saving in water by re-designing the equipment was only 3%. Major improvements were, instead, brought about in the uniformity of water distribution. The 17 growers had been carefully selected, and on the whole had not been applying an excessive amount of water at each application.

TABLE 1. PERCENTAGE OF WATER AND TIME SAVED BY SCHEDULING, AS COMPARED WITH STEADY IRRIGATION

	% time saved as determined by Formula 1	% time saved as determined by Formula 2
1962	24.8	28.6
1963	28.4	32.7
1964	46.5	53.6
1965	46.1	51.2

The assessment of net savings from irrigation was found to be difficult.

Two methods were used:

1. Total flow in the Southern Okanagan Lands Project canal was measured daily from May 16 to September 16 in 1963, and from May 4 to September 24 in 1964. The average flow for each season was determined, and was expressed in percentage of the peak flow. This was considered to represent approximately the average percentage of time that the growers who were not scheduling were irrigating. To compare with this, the same procedure was used in the 17 orchards where irrigation was being scheduled, and for the same periods of time (table 2). It should be noted that irrigation started each year about May 1, so some early records were missed. In table 2 the values for growers scheduling differ from those in table 1 because in table 2 the same length of irrigation season is used for all orchards.

In order to determine the savings in water and labor by scheduling as compared with so-called "normal" irrigation, the average percentage of peak flow in the canal was used as a base. By way of example, the average canal flow in 1963 was 100.0 — 12.0 = 88.0%. The average time of water use by the 17 growers (formula 1) was 100.0 — 25.4 = 74.6%. These growers, therefore, irrigated 100(74.6/88.0) = 84.8% as much as did all the growers on the canal. Their net saving of time and labor was 100.0 — 84.8 = 15.2%.

2. In 1965, daily measurements were made of total water flow to 543 acres of orchard land in the Oliver District. This area was served by a pump and by delivery pipes which constituted a closed system, so there was no water wastage except in application of water in the orchards. The period of calculation was from May 1 to September 16 although there was some slight flow after the latter date. Of the 543 acres, 135 acres were under commercial scheduling of irrigation; in other words, the growers used soil moisture balance-sheets and looked after their own scheduling.

The peak use of water on the 543 acres was 6.74 U.S. gpm per acre. Average use of water for the period was 71.6% of this, which meant that growers were irrigating on the average only 71.6% of the time. Compared with this the average time of application by growers on scheduling was 53.9% using formula 1 and 48.8% using formula 2. On this basis, growers on scheduling saved 24.7% of their water and time using formula 1 and 31.8% using formula 2. Actual savings may have been higher than this because 135 acres of the area were under scheduling, and because a concerted effort was made to persuade all growers not to irrigate unless necessary. Records of savings of time and water because of scheduling on this 135 acres were not available.

DISCUSSION

Savings in water and operating time ranged from 15% to 57%, depending on the year and on the method used to measure the savings.

Certain questions about the results remain unanswered. The first question is, is it fair to make a comparison between irrigation under scheduling and steady irrigation? At first glance the answer is no, because some growers discontinue irrigating at times during the season anyway. On the other hand, the growers who are scheduling find that they can safely place their faith

TABLE II. PERCENTAGE OF WATER AND TIME SAVED BY SCHEDULING, AS COMPARED WITH NOT SCHEDULING

	May 16 to September 16 1963	May 4 to September 24 1964
Canal flow		
Peak flow, cfs	164.0	164.0
Average flow, cfs	144.2	156.4
Water and time saved, %	12.0	4.7
Growers scheduling, compared with steady irrigation		
Days in period	124.0	144.0
Days irrigating (formula 1)	92.5	71.4
Water and time saved, %	25.4	50.4
Days irrigating (formula 2)	78.4	62.1
Water and time saved, %	36.8	56.9
Savings in water and labor in % of the savings without scheduling		
By formula 1	15.2	48.0
By formula 2	28.2	54.6

in the balance sheets without any fear of their soil getting too dry. This deserves considerable weight in assessing the value of scheduling.

The second question is, which is the more reasonable procedure, use of formula 1 or formula 2? Interviews with a large number of growers indicate a natural tendency to irrigate without stop during the heat of the summer, irrespective of whether or not they can get around faster with the sprinkler lines than they need to. Perhaps somewhere between formula 1 and formula 2 would be more nearly correct.

The use of canal flow as a basis for normal irrigation may be subject to some question. Some leakage occurred along the canal, and some excess water was discarded over spillways. It was not possible to determine whether or not leakage and spilling were proportional to water use. It is conceivable, therefore, that savings calculated on this basis may not be entirely accurate; on the other hand, there is no good reason for discounting the results obtained.

In spite of the above qualifications, it is obvious that in this investigation substantial savings in water and time were effected by scheduling; and this was accomplished with (as far as is known) complete security in so far as maintenance of soil moisture within the optimum range was concerned.

The re-designing of growers' irrigation systems brought about negligible savings in time and water. The growers were, of course, specially selected. On the whole, they were not applying too much water at each application prior to 1962. Many growers, however, do apply excessive amounts of water (3). Scheduling provides a means whereby advice can be given with respect to the design of the sprinkler system, and this has been found to save much water in individual cases where growers are doing their own scheduling. The additional contacts brought about between extension personnel and growers constitute a distinct benefit from the scheduling procedure.

SUMMARY

...s were scheduled for four ...rchards on soil types vary- ... soil texture and depth. ... by the sprinkler method ...rtable lateral lines. As compared with steady irrigation, scheduling saved from 25 to 54% of the water and operating time, depending on the year and the method of measurement. Estimates were also made of normal savings without scheduling. Measurement of canal flow showed average use of 88% and 95% of peak use in 1964 and 1965 respectively. Adjusting for this, scheduling by growers brought about net savings of from 15 to 55% of the water and time. A similar study based on a closed system in 1965 showed net savings of 25 to 32% as a result of scheduling. It is concluded that scheduling can save much water and operating time, without fear of adverse effects on the soil moisture content.

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