# WEATHER DATA, WATER USE, AND POTATO PRODUCTION

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## INTRODUCTION

The purpose of this paper is to summarize the climatic effects on water use for potato growth on sprinkler irrigated fields from a field investigation made in the East High area of the Columbia River Basin near Moses Lake, Washington, during the 1971 and 1972 irrigation seasons. This investigation required the use of weather station equipment from which daily climatic data were documented for water use crop requirements.

Water delivered to a sprinkler irrigated area must provide for (1) evapotranspiration or consumptive use of a crop (2) sprinkler losses and (3) unavoidable deep percolation losses beyond the root zone profile. The first is dependent on meteorological conditions and the stage of crop growth when water is not limited. The second is dependent on the type of sprinkler system installed and the ability of the irrigated soil to absorb a water application. The third is dependent on management or the high moisture level maintained in the root zone profile prior to an irrigation.

Various emperical methods are available for estimating or predicting evapotranspiration from meteorological parameters. Farm operators interested in crop requirements are probably more concerned in a simplified rule of thumb type parameter, which requires less time and effort, than complex equations to predict a scheduled irrigation. Today's management requires the use of some reliable method to determine the time and the amount of water for an irrigation, so adequate crop growth may be obtained.

An irrigation for potatoes is usually required whenever the soil moisture depletion is about 35% of the available moisture in the root zone profile. Water delivered to irrigated areas by a sprinkler system must provide for this depleted soil moisture and some unavoidable water losses during each irrigation. Excessive water applications will reduce the potential yield and quality of some crops as readily as delayed or inadequate irrigations.

## CLIMATIC EFFECTS

A weather station was installed during April 1971 near the East High study area. This station was equipped to obtain the following information: (1) Solar Radiation (2) Pan Evaporation (3) Maximum Temperature (4) Minimum Temperature (5) Relative Humidity (6) Wind Movement and (7) Precipitation.

Temperature is an energy exchange, but is only that portion of radiant energy related to heating the air. Parameters developed from temperature measurements are used to some extent since temperature data are available in most areas. Methods of estimating evapotranspiration using mean temperatures have been reasonably successful and accepted on a seasonal basis. Temperatures used as a single climatic parameter in estimating evapotranspiration for short periods during an irrigation season are not widely accepted.

Below normal temperatures which occurred during the 1972 peak growing period reduced the potential yield of potatoes by about 15% to 20% in the East High study area. Occasionally early season frost occurs and causes some serious local crop damage.

Relative Humidity is a ratio of the quantity of water vapor actually present in the surrounding air to the greatest amount of water vapor possible at a given temperature. Data recorded at the

East High weather station, when no precipitation occurred, indicated the relative humidity ranged from about 30% to 50% in the late afternoon to about 70% to 90% in the early forenoon hours.

Wind is the movement of air over the land surface and is usually recorded in miles per hour and/or total movement in miles per day. Air movements above normal in an irrigated area usually increase to some extent the evaporation of land surface moisture, transpiration of plants, sprinkler losses, pan evaporation, etc. The increased effect is not likely to be the same percentagewise for each of the losses, as other climatic factors have an important role in the net result.

Wind movement recorded in the study area varied from 50 to 300 miles per 24 hours during the 1971 and 1972 growing seasons.

Precipitation is one of nature's methods of supplying moisture to the depleted soils. Unfortunately, it does not furnish the necessary moisture in sufficient quantities and at the proper times to satisfy the potential growth of a crop. This does not mean that rainfall should be disregarded; on the contrary, it must be considered as a supplemental supply which may alter a decision for the next predicted irrigation.

Records from nearby weather stations indicate the average growing season precipitation to be about three inches in the Columbia Basin area. The 1971 and 1972 measured rainfall was normal with about three inches occurring during the growing period.

Cloud Cover is a natural condition in which a land area is blanketed with an umbrella effect. When cloud cover occurs, a portion of the radiant energy which would normally reach the surrounding air and land surface is reflected back from the atmosphere and clouds. This has a tendency to reduce the evapotranspiration rates and the crop water requirements to some extent. Radiant energy variations can also be caused by smoke, dust, and haze which occur in some areas.

Solar Radiation is a physical measurement and is directly associated with energy available for evapotranspiration. Parameters developed from solar radiation have an advantage over temperature parameters in that short-term evapotranspiration estimates can be developed with a certain degree of accuracy. Solar radiation is usually expressed as an evaporation equivalent in inches or millimeters per day. The evapotranspiration of potatoes in the East High area was estimated by the Jensen and Haise method, which uses solar radiation as the main parameter. This method incorporates mean air temperatures and other related climatic factors to the main parameter. In addition, crop coefficients are used for various stages of growth to estimate the crop requirements.

Pan Evaporation is a measurement expressed in inches per day which can be used to develop parameters for estimating the evapotranspiration of a crop. The U. S. Weather Bureau Class A pan, four feet in diameter and 10 inches in depth is the most widely used pan for this purpose. It is usually exposed on a wooden frame with the water maintained at a level of seven to eight inches deep. U. S. Weather Bureau standards should be used when an evaporation pan is installed for reliable results. Structures and trees nearby or the absence of actively growing grass influences the evaporation rate considerably.

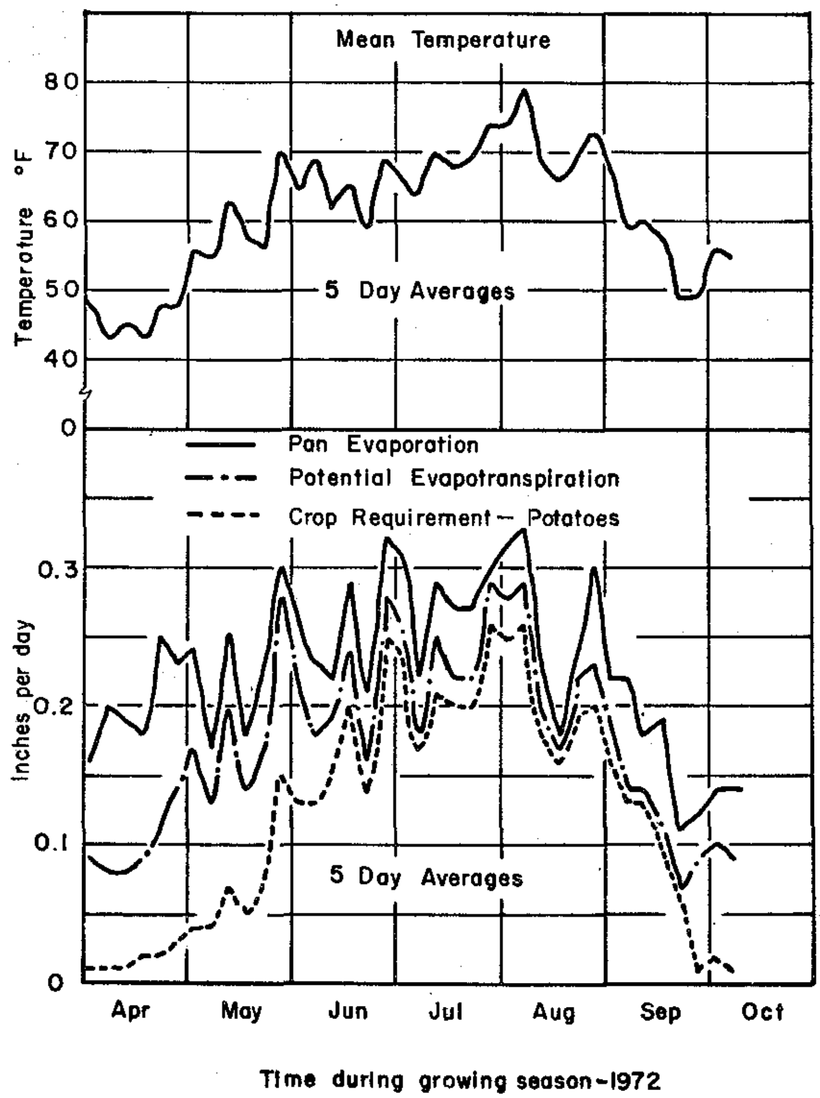
A variable coefficient must be used for evapotranspiration estimates during the season to adjust for varying crop cover and stage of growth. Recommended coefficients are generally more reliable for longer time periods, such as a month or a season, and less reliable for five- or ten-day estimates.

## RESULTS

Figures 1 and 2 illustrate some of the climatic factors and their relationship to evapotranspiration for a potato field in the East High area near Moses Lake, Washington, during the 1972 growing season. These curves were plotted using five-day running averages, so the general climatic trend could be readily visualized rather than the daily extremes which occur at various times during the season.

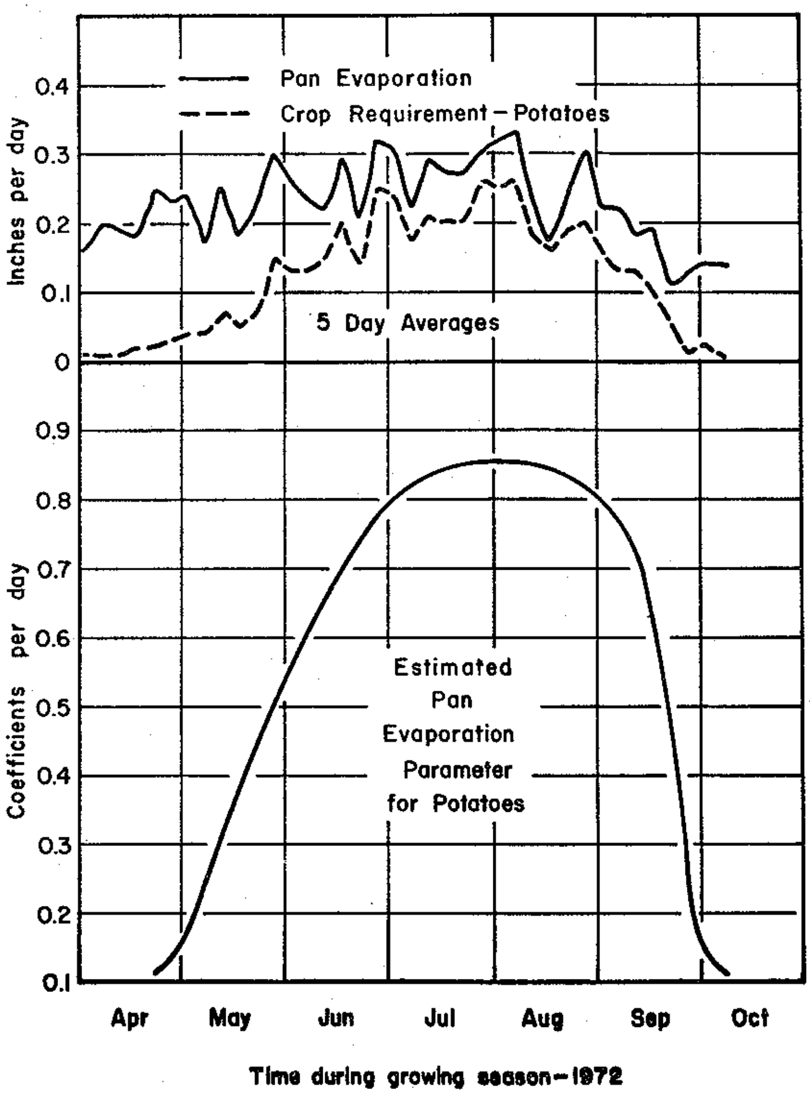
Mean daily temperature values throughout the growing season are shown on Figure 1. Pan evaporation, potential evapotranspiration from the solar radiation method and the estimated crop requirement for potatoes are illustrated in Figure 1 for visual comparison. Available procedures for estimating evapotranspiration from radiant energy related to temperature lack the simplicity and ease that solar radiation or pan evaporation methods have for the development of reliable parameters. The radiation and evaporation curves shown in Figure 1 readily indicate that variable coefficients must be used to obtain estimated crop requirements during the season from planting time to full vegetative cover.

Figure 1




The use of the evaporation pan in the State of Washington and surrounding areas is very predominant. For this reason a pan evaporation parameter was developed (Figure 2) relating the daily crop requirement estimates with the daily pan evaporation measurements from the 1972 field investigation data. The parameter or crop coefficient curve for potatoes was made by using five-day running averages on clear days for maximum evapotranspiration estimates. A visual graph of this type can be used as a simple rule of thumb estimate in predicting when the next irrigation should take place. Coefficient curves for the other crops could be developed in the same manner as as the one illustrated in Figure 2.

Figure 2

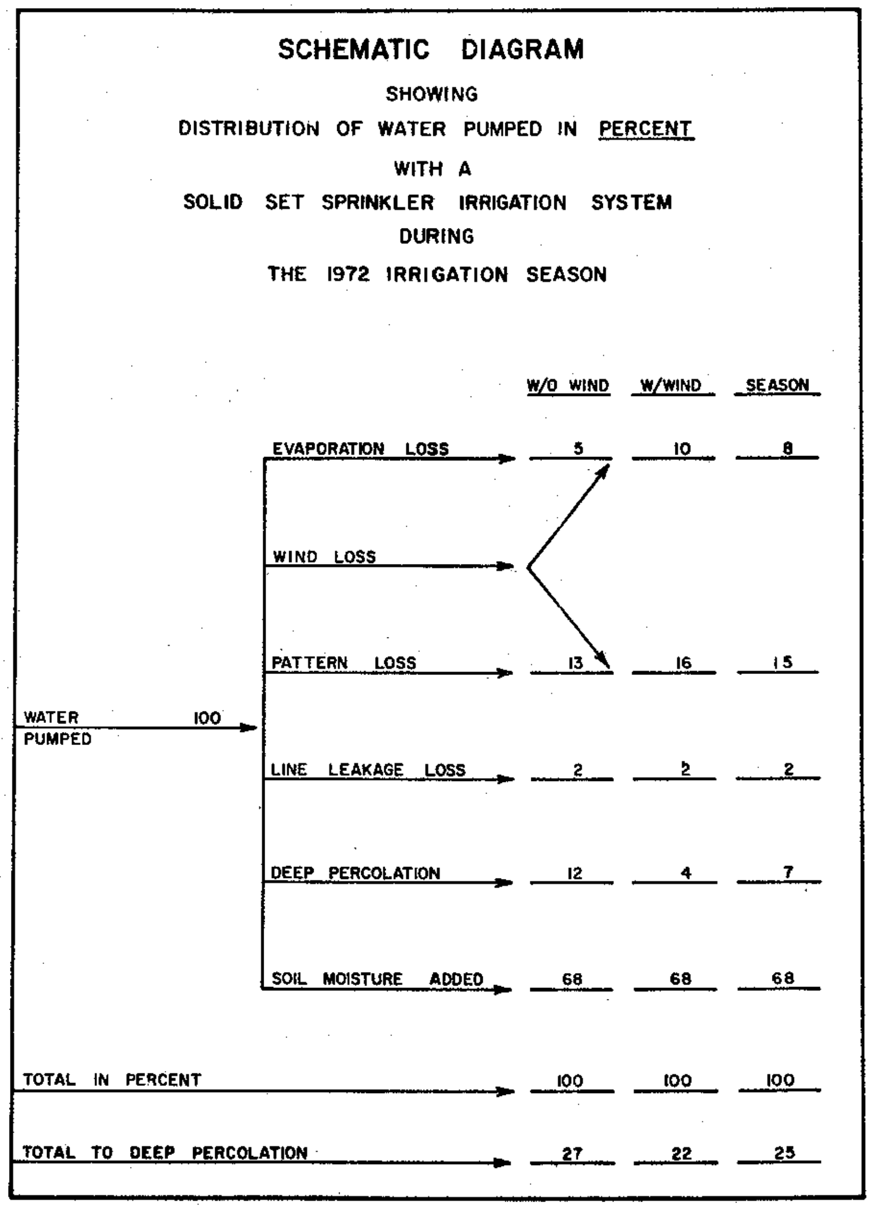



Whenever rainfall or extended cloudy weather conditions prevailed, scheduled irrigation adjustments could be made by simply checking the soil moisture in the field with a soil moisture probe or by some other adequate means. Frequently an individual irrigator guesses when irrigations are needed even though a number of relatively inexpensive soil moisture instruments are available commercially.

Water transpired, plus that evaporated from soil or plant surfaces, has received considerable attention for many years. Various climatic parameters for estimating crop requirements have been developed through the years and are being continually improved with the use of new and more reliable climatic data. A meteorological parameter is satisfactory, whenever its relationship to evapotranspiration estimates of a crop is adequately met for short-term periods, and is readily accessible for farm management use.

A schematic diagram (Figure 3) shows the distribution of water pumped in percent with a solid set sprinkler irrigation system in the East High area during the 1972 irrigation season.

Figure 3



As stated earlier, evapotranspiration or consumptive use estimates for potatoes were determined from the solar radiation method. With this method soil moisture depletion estimates for a crop may be made at any time during the irrigation season using the energy-water budget approach.

Water application estimates for the land irrigated with a solid set sprinkler system were obtained using plastic catchments. When these catchments are properly spaced, one can determine if the estimated crop consumptive use requirements are satisfied. One can also determine the sprinkler losses from a metered pump delivery to the effective distribution of water applied on the land irrigated.

Sprinkler losses, as defined in this study, include evaporation loss, wind loss, pattern loss, and line leakage loss. The wind has an additional effect on the evaporation and pattern losses, and these losses are relative to the velocity of the moving air over the land surface.

The solid set sprinkler losses were estimated at various times during the irrigation season. These losses are the difference in the amount of water pumped and the amount of effective water applied to a land area for the same period of time. During an irrigation period the losses varied from about 20% to 28% of the pump delivery. The variations were attributed to changes in pump deliveries and climatic conditions.

Whenever the air movement over the land surface was of normal velocity, the estimated sprinkler evaporation loss during the peak period varied from 5% to 10% of the pump delivery. This evaporation loss was the amount of water pumped less the total water applied to the land for the same period of time. Calibrated plastic catchments with a graduated scale designed to measure from one hundredth of an inch to six inches of rainfall were used to obtain this data. These catchments were placed in a grid 10 feet apart in two sets, with 25 in each set, and were located near each end of the sprinkler lateral lines.

The soils in the East High area have six to eight feet of silt loam over hard caliche. These soils have a weakly cemented lime layer within four to five feet of the soil profile that tends to retard the downward movement of water. Available soil moisture for crop growth from laboratory determinations was estimated at about three inches per foot in most of the study area.

Water applied to the Shano series soils indicated a maximum intake rate of about two-tenths of an inch per hour from field investigations. Well water was delivered to the study area lands with solid set sprinklers spaced 40 by 60 feet apart, at a rate of about four gallons per minute per sprinkler to avoid runoff losses. Application of water was usually made in five-hour sets every 56 hours, or about three applications per week during the peak period. The sprinkler system was automatically controlled with an installed electronic device.

An average summary of measured and estimated data obtained during the 1971 and 1972 field investigations for 155 acres of potatoes on a seasonal basis in round figures are as follows:

| Field Data | 1971-72 Average May thru September |
|---|---|
| 1. Pan Evaporation | 38 inches |
| 2. Potential Evapotranspiration | 29 inches |
| 3. Crop Requirement - Potatoes | 23 inches/acre |
| 4. Amount of Water Pumped | 31 inches/acre |
| 5. Sprinkler Losses | 7 inches/acre |
| 6. Deep Percolation | 4 inches/acre |
| 7. Soil Moisture Added | 20 inches/acre |
| 8. Precipitation | 3 inches |
| 9. Potato Yield | 30 ton/acre |

## SUMMARY

Predictions of evapotranspiration with the use of basic climatic parameters are essential in assessing the irrigation water-management efficiency for a farm area. Management should have some knowledge of how much soil moisture there is available in the root zone profile for adequate crop growth when filled to field capacity. In fact, it is imperative for the farm operator to make use of available climate, crop, soil, and soil moisture data which would increase the yield and quality of an irrigated product.

The potential for better irrigation water management has increased substantially in recent years with better water control and measurement facilities, improved sprinkler system design criteria, more reliable methods for estimating evapotranspiration, and increased knowledge of each crop's response to type of soil and soil moisture levels. Present day sprinkler systems can be geared to apply water at a reasonable rate and at the proper intervals to meet the crop consumptive use requirements without excessive runoff and deep percolation losses.

Successful farm management can only be accomplished by having a knowledge and an interest in nature's natural resources. The climatic and soil moisture relationship used for evapotranspiration estimates, should be a simple reliable method that meets the desired crop water requirements throughout the growing season. In other words - for the best results, stay in the ball park.

## ACKNOWLEDGMENTS

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