IRRIGATION WATER MANAGEMENT IN POTATOES: DROUGHT CHALLENGES

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Potato yield and quality can be significantly reduced by both under and over-irrigation. For example, under-irrigation can reduce the number of tubers, produce undesirable tuber shapes, and increase potential for disease infection. Over-irrigation can leach water-soluble plant nutrients and increase disease potential. Therefore, to minimize disease potential and achieve maximum yield and quality, irrigation equipment must be designed, maintained, and operated to uniformly apply the correct amount of water at the proper time.

Growers faced several irrigation-related challenges during drought growing seasons. The following problems may be encountered:

- Capacity of center pivot systems plus insufficient soil moisture storage to meet peak ET needs.
- Continuing irrigation continued at the peak rate after crop water use drops off.
- Poor application uniformity.
- Surface runoff under pivots and set-move systems.

RESULTS OF IMPROPER IRRIGATION WATER MANAGEMENT

Potatoes are a water-sensitive crop and require a season-long assured water supply. Water stress reduces crop yield and quality and also makes the plants more susceptible to a number of diseases. Stark and Love (2003) describe potato diseases with a connection to irrigation water management. Some of these diseases and tuber shape problems are:

Water stress during stolonization and tuber set reduces the number of tubers and increases

Several factors must be considered when evaluating the adequacy of system capacity. These include system application efficiency, long-term average evapotranspiration (ET), and seasonal ET for higher than normal ET years.

System Application Efficiency (AE): Only a portion of the water applied by the sprinkler system ends up in the crop root zone. The rest is lost to evaporation, wind drift, leaks, and non-uniformity. Application efficiency for a well-maintained pivot is about 85%, and can drop to as low as 70% for a poorly-maintained system. Application efficiencies are about 70% for solid set or set move systems under low to moderate wind conditions, and drop to 65% in higher wind conditions. Another way of looking at application efficiencies is that to place 1 inch of water in the crop root zone, the amount of water applied by the system (gross irrigation) would be 1/0.8 or 1.25 inches for 80% AE, 1.4 inches for 70% AE, and 1.5 inches for 65% AE.

Most center pivot systems are designed to deliver gross irrigation of 6.5 gpm/ac in Eastern Idaho, 6.5-7 gpm/ac in the Magic Valley, and 7-7.5 gpm/ac in Western Idaho. Using an application efficiency of

this may mean re-nozzling to a higher application rate (if surface runoff is not a problem) with additional water supplied from another source. If additional water is not available, consider one of two options: 1) reduce acreage and re-nozzle to meet peak ET by using water from corners or the end gun area, or 2) plant half the pivot to grain and half to potatoes. Although this is less convenient, grain irrigation can usually be curtailed by the time the potatoes need extra water. This option can also be less than convenient for pivots without programmable panels, but it can prevent water stress and assure a higher quality crop.

IRRIGATION CONTINUED TOO LONG AT THE PEAK RATE

As shown in **Figure 4**, ET rates can drop quickly during late season as the plants begin to senesce. Since this period follows the period of peak water use, it is imperative to monitor soil moisture conditions carefully to detect the drop off in ET and avoid excess soil moisture. Excessively wet soils can produce enlarged, open lenticels that allow soft rot bacteria to enter the tubers. Excessive late-season soil moisture can also increase pink rot and Pythium leak infections (Nolte et al., 2003).

POOR APPLICATION UNIFORMITY

As indicated in UI Bulletin 824 "Irrigation Uniformity" (King, et al., 2000), in a system with poor application uniformity about 34% of the field area will be over-watered by more than 3 inches, with an equal area under-watered by the same amount. Only 10% of the field area will receive optimum irrigation. In contrast, a system with high uniformity will over or under-water only 9% of the field area by more than 3 inches, while 34% of the field will receive optimum irrigation. The difference in potato crop value between these two situations was estimated to be about $140/acre (King et al., 2000).

Poor system uniformity in pivots and linear move systems can be caused by plugged or sticking pressure regulators (**Figure 5A**) or by nozzles placed in the wrong location (**Figure 5B**). In general, pressure regulators on low-pressure systems have a useful life of about 10,000-14,000 hours (about 5-7 years), depending on the quality of the irrigation water. As they age, the moving parts within the regulator tend to stick in one position, particularly in water with high levels of dissolved minerals. As a result, the output of a 15 psi regulator may range from 5 to 25 psi, creating bands of over or under-watering.

Surprisingly, a significant number of pivots have had nozzles installed in the wrong location. This also produces bands of over or under-watering (**Figure 5B**). Therefore, taking the time to double-check the location of nozzles on a new or re-nozzled system is certainly worthwhile.

Correct system operating pressure is essential for good water application uniformity under solid set or set-move systems. Poor uniformity can be produced by either insufficient or excessive system pressure (**Figure 6**). The optimum pressure for brass nozzles is about 40-60 psi. When water applied by nozzles operating in this pressure range (**Figure 7**, center) is combined by overlapping patterns, the

result is a relatively uniform irrigation depth across the field. At lower pressures, more large water droplets are formed, producing the pattern shown in **Figure 7** (top) and **Figure 8**. Excess pressure produces more small droplets which are prone to wind drift and evaporation and produce the pattern shown in **Figure 7** (bottom). Water application uniformity resulting from overlapping patterns shown in the top or bottom part of **Figure 7** will be lower than that from overlapping the distribution shown for proper nozzle pressure. This poor distribution can result in areas of significantly higher or lower than average water application depths.

SURFACE RUNOFF PROBLEMS UNDER SPRINKLER SYSTEMS

Ideally, irrigation systems are designed to uniformly apply the correct depth of water. Surface runoff occurs when water is applied at a rate high enough to exceed water movement into the soil (infiltration rate) and fill water storage due to surface roughness.

The presence of surface runoff means that some areas are not receiving the intended water, and other areas, where the water ponds, are receiving excess. As mentioned previously, both insufficient and excessive irrigation can reduce crop yield and quality.

In addition, areas of excess water tend to be “hot spots” for disease development. Runoff from center pivots tends to collect in pivot tracks. Potato diseases that favor wet soil conditions tend to start near pivot tracks and in the chronically over-watered area under the first span. If conditions are favorable, disease then spreads to the rest of the field. Pesticides and fertilizers applied through the irrigation system are also non-uniform if the water uniformity is less than ops5 0 TDee9ssure. o 50i oest to(runoffuan)4.7 prinklter y(stem)6.7((istruely)-5.5(“wa(sted wat)6.7(e).8r,”t som)6.7(e).8thvingno ionn ce)6In fifoed tisp yar.

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Within the “continuous, gentle rainfall” group, Spinners will produce smaller droplets. Drop size for the Wobblers or Iwobs can be reduced by increasing pressure (higher pressure = smaller drops). Although spray nozzles are inexpensive and can produce small droplets at the correct pressure, the wetted diameter is only about 20 feet, or only 20% of the area covered by all the application packages listed above. As a result, the application rate is about 5 times higher under the spray nozzles, making them more prone to surface runoff on the outer pivot spans.

SUMMARY

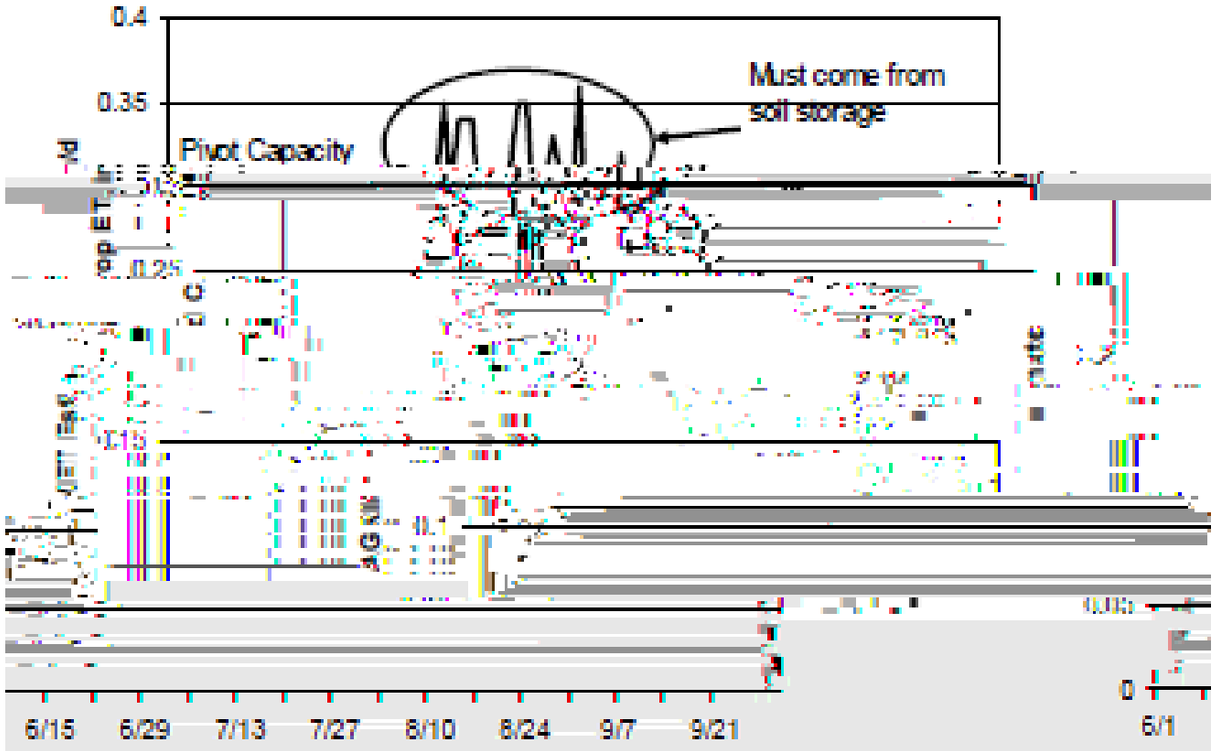
Proper irrigation water management is essential for minimizing the potential for disease and for optimum potato yield and quality. In general, this means applying the correct amount of water to the crop at the correct time and applying it as uniformly as possible. Specifically, this means:

- Assuring that the irrigation system is designed to meet peak season water requirements, considering any root zone water storage that may be possible
- Early season management to assure that soil water storage in the crop root zone is filled before peak ET occurs
- Carefully matching water application to ET in mid-late season to avoid over-irrigation as ET drops off due to crop senescence
- System maintenance to assure best water application uniformity
- System design and management to minimize surface runoff

REFERENCES

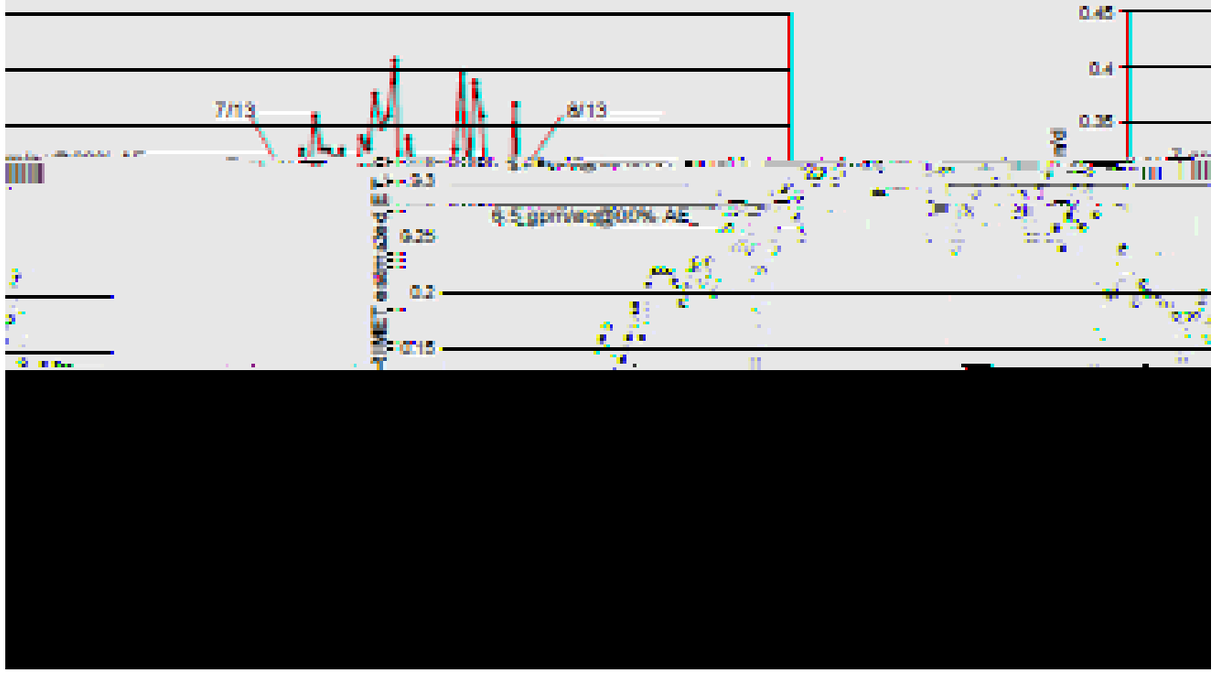
King, B.A., J.C. Stark and D.C. Kincaid. 2000. Irrigation Uniformity. University of Idaho Bulletin 824. 11pp.

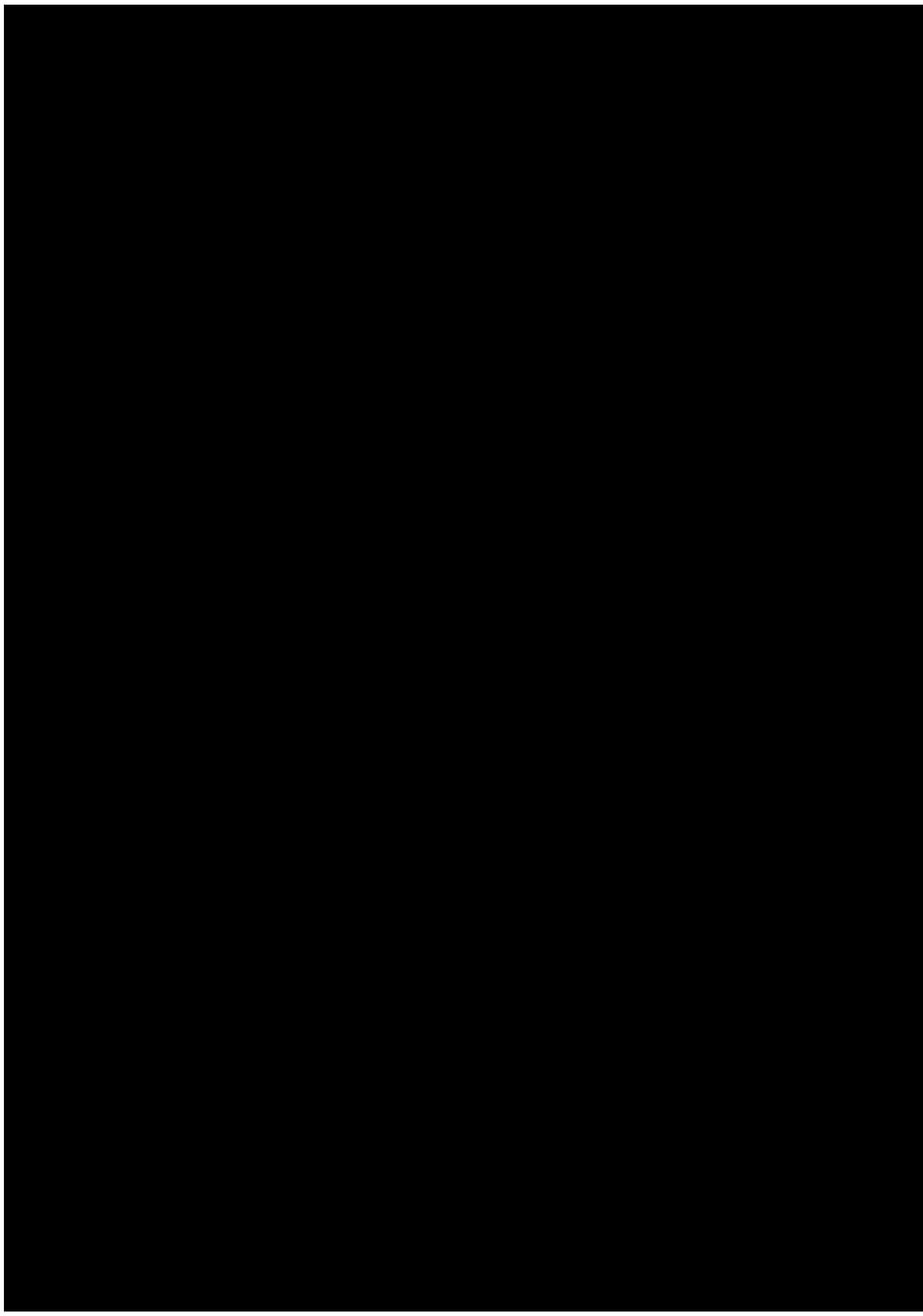
Nolte, P., J.S. Miller, B.D. Geary and D.L. Corsini. 2003. “Disease Management”, Chapter 10. In: Potato Production Systems. J.C. Stark and S.L. Love, ed. Agricultural Communications, University of Idaho. Moscow, ID. 426 pp.

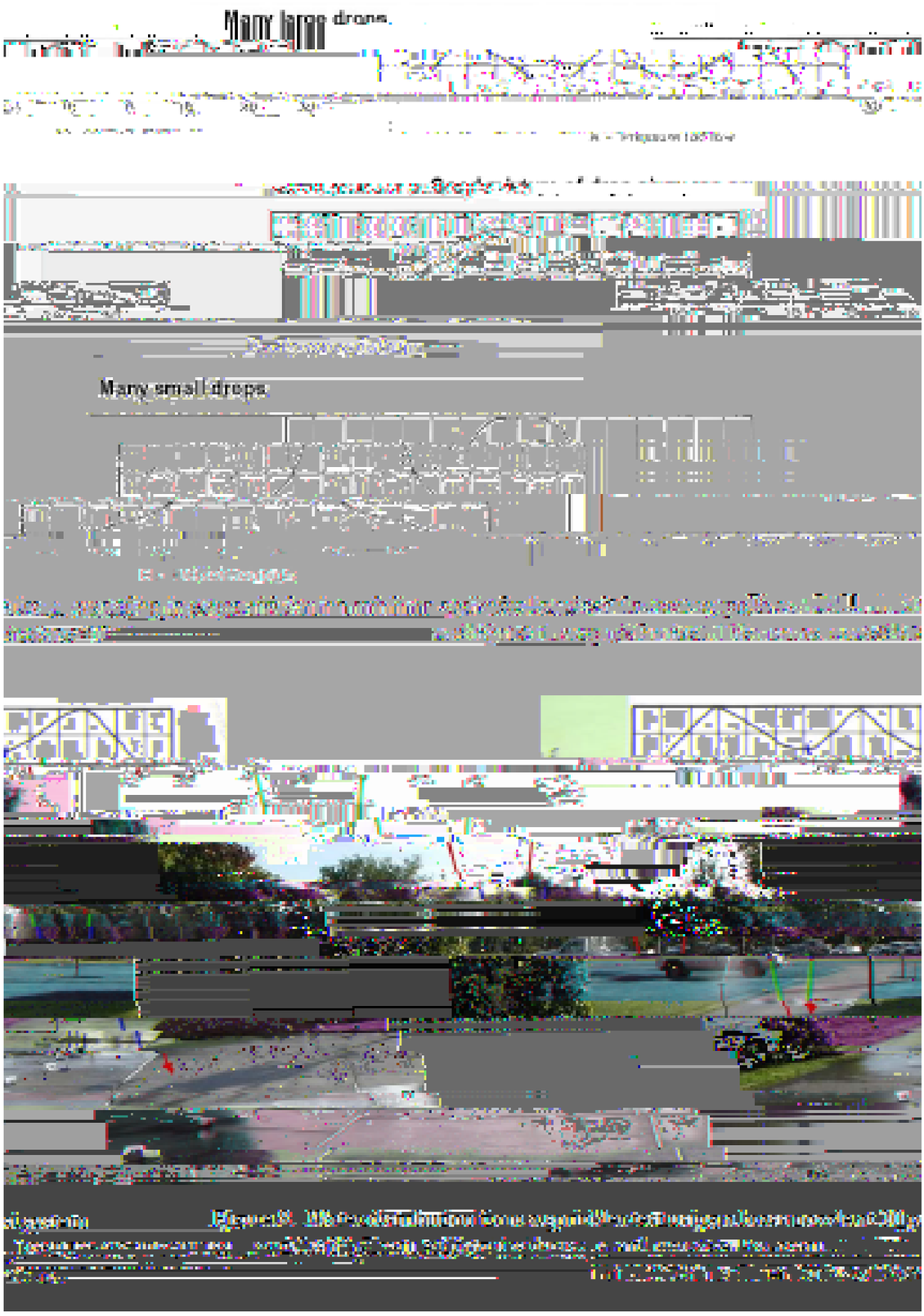


ar average and 2004 estimated ET for Russet Burbank potatoes at
Pivot capacity is 7 gpm/ac (0.3 in/d net irrigation)

Figure 1. 30-ye
Kimberly, ID.






Many large drops
Many small drops