IRRIGATION WATER MANAGEMENT TO MINIMIZE DISEASE POTENTIAL IN SUGARBEETS

Howard Neibling and John Gallian[1]

Sugarbeet yield and sugar content can be significantly reduced by both under and over-irrigation. For example, under-irrigation reduces beet tonnage and total sugar yield, while over-irrigation can leach water-soluble plant nutrients and increase disease potential. Therefore, to minimize disease potential and achieve sugar yield, irrigation equipment must be designed, maintained, and operated to uniformly apply the correct amount of water at the proper time.

SUGARBEET IRRIGATION WATER MANAGEMENT NEEDS

Establishment (seed to 4-leaf; the first 30 days after emergence): Because beets are planted less than 1-inch deep, frequent, light irrigations may be needed to provide adequate soil moisture for germination and emergence under high ET or low water-holding soil conditions. On soils that tend to crust (high-silt or other), if irrigation during this period is needed, it should be light and frequent. Irrigation system components should be selected to deliver small, low energy droplets continuously over all parts of a large-diameter wetted pattern. The goal is to minimize the kinetic energy applied to the soil and minimize development of a surface crust. If a crust is formed by a rainfall event, irrigations should be light and frequent to keep the soil surface moist until the seedlings emerge.

One practice that is helpful in minimizing crusting under center pivots during this period is the use of a dual-nozzle clip which allows a second set of nozzles to be stored on the pivot drops. About 1 hour is usually required to change from one nozzle set to the other on a typical ¼ mile machine. The second set of nozzles is designed to apply about 2/3 of the mid-season design application rate. The lower application rate reduces the potential for crusting and runoff. After the crop establishes adequate cover, the nozzles can be quickly changed to allow the system to meet the mid-season irrigation demand.

Beet roots advance slowly downward, requiring about a month to reach a 1-foot root depth. Moist, non-compacted soil is essential for root development. During the first month, frequent irrigations on light, low water holding soils may be needed to maintain adequate soil moisture in this shallow root zone. This may also be true during periods of early-season hot, windy weather.

Excess water during this period can increase the potential for Rhyzomania development. Irrigation should be the minimum required to promote good crop emergence and then reduced to keep soil moisture dryer, but still above 50% available soil moisture in the active root zone (top 1 foot).

Sugarbeet diseases require a minimum soil temperature for initial development. Several also require moist soil conditions. For example, Rhyzomania requires temperatures above 70 deg F in the top 4 inches for disease development. As shown in Figure 1, adequate soil temperatures occur between early June and mid September. It also requires moist soil conditions, with soil matric potential between zero (saturation) and -40 centibars (cb), as shown in Figure 2.

Irrigation system design and operation can determine the percentage of time that soil moisture falls in the optimum range for disease development. Figures 3-6 show the seasonal soil moisture variation for different management strategies. All figures assume 7 gpm/ac center pivot design and a silt loam soil

1

at Kimberly. Data are for the 2004 crop year. Similar data could be shown for a number of other years such as 2003, 2006, etc., but the trends are clearest for the 2004 data.

When the maximum root zone depth is filled to field capacity before June 1, an adequately-designed center pivot can be managed to maintain relatively constant soil moisture during the growing season. If soil moisture starts out dry (in this case at 50% available moisture), soil moisture drops off as the season progresses (Figure 3). In Figure 3, the center pivot was operated to re-fill the soil to field capacity with early season irrigations, and on a 2.5 day interval during mid-season. Under this management strategy, soil moisture was favorable for disease development early in the season. However, with adequate early-season moisture, the profile could be dried out somewhat and soil moisture maintained at a less favorable moisture content for disease while still in a near-optimum moisture range for plant growth (Figure 4). Note that this would not be possible at less than 7 gpm/ac – soil would dry excessively as discussed later. Similar results are shown in Figures 5 and 6 for a set-move system.

Vegetative and yield formation (4-16 leaf; about 3 months). Water stress during this period reduces root and top growth. Yield reduction is about 7-11% for each 10% of ET deficit. ET during the June 1 – September 1 period averages about 23.5 inches at Kimberly, so a 10% deficit would be about 2.4 inches. If soil moisture in the second and third foot is below field capacity, additional irrigation to fill the deeper root zone should occur after establishment and before lay-by (typically late June to early July). Because soil temperatures reach the disease threshold by early June, it may be desirable to add extra water to fill the root zone before then if farming schedules allow. Dry surface soil moisture at lay-by is necessary since throwing moist soil into the crown at lay-by is a major way to move Rhyzoctonia root rot pathogens into the beet plant.

To minimize disease problems in this period due to excess water:

- Monitor soil moisture to avoid over-watering
  - Irrigate for the majority of the field
  - Optimum growth is in the -40 to -60 centibar (cb) range
  - Keep slightly dryer (-60 to -80 cb) when Rhizoctonia is a problem on silt loam soils
- Fix leaks in lines
- Reservoir till or otherwise eliminate surface runoff
- Minimize time of wet foliage (slower pivot speed but without runoff)

Excess irrigation during this period may also move N from the upper to lower portions of the root zone. This produces a nutrient deficiency followed by excess N later in the season when lower nitrate values are needed to maximize sugar extraction.

ASSURING ADEQUATE SYSTEM CAPACITY

An irrigation system with adequate capacity gives a grower more management options to both meet crop water needs and minimize conditions for disease development. In contrast, an under-designed system minimizes grower options and requires wet soil conditions during portions of the growing season to help meet ET needs during mid season. For optimum beet growth, the combination of soil moisture storage and system capacity must be able to provide sufficient water during the highest water use parts of the season. Most hand line, wheel line or solid-set systems are designed to meet peak ET. However, to reduce equipment costs, most center pivot systems in Idaho are designed to meet only 80-90% of peak ET (Figure 7). This means that the remainder of the mid-season crop water demand 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. Disease potential is greatest in the areas of over-irrigation (34% of the field for poor uniformity vs. 9% for good uniformity).

Poor system uniformity in pivots and linear move systems can be caused by plugged or sticking pressure regulators (Figure 9A) or by nozzles placed in the wrong location (Figure 9B). In general, overtop and destroy the future effectiveness of the treatment.

On soils prone to surface sealing and runoff, water should be applied in a manner that produces the lowest droplet kinetic energy per unit area. This means applying smaller droplets over a larger area. Some application packages (Wobblers[2], Iwobs, Spinners) apply water in all areas of a wetted circle at once. Application resembles a gentle rainfall. Others, such as rotators, apply water in a few slowly-rotating high-intensity streams which apply more kinetic energy per unit area and produce more severe crusting and runoff.

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 sugar production. 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 ensure that soil water storage in the crop root zone is filled before peak ET occurs

- 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.

[2] Product names are included for reader benefit and do not imply endorsement by the University of Idaho.

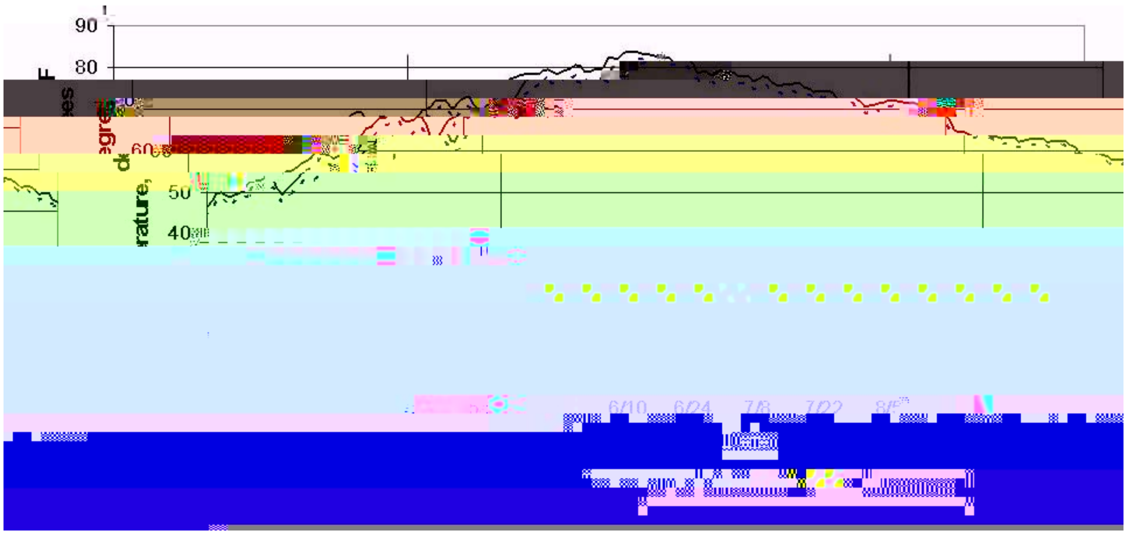


Figure 1. 2006 soil temperature at the 4-inch depth. Data are from the Kimberly, ID AGRIMET weather station.

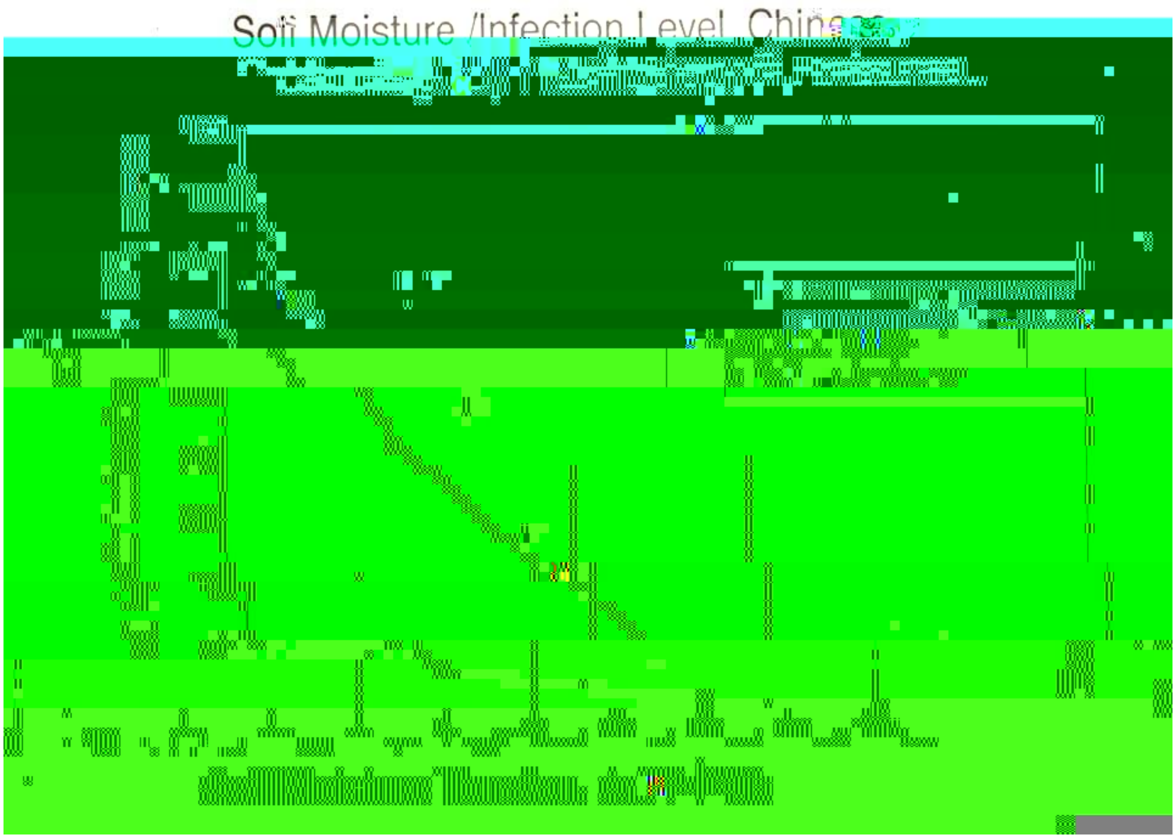


Figure 2. Root hair infections of Chinese cabbage by Plasmodiophora Brassicae and Polymyxa betae and BNYYVV (Gerik et at., 19)

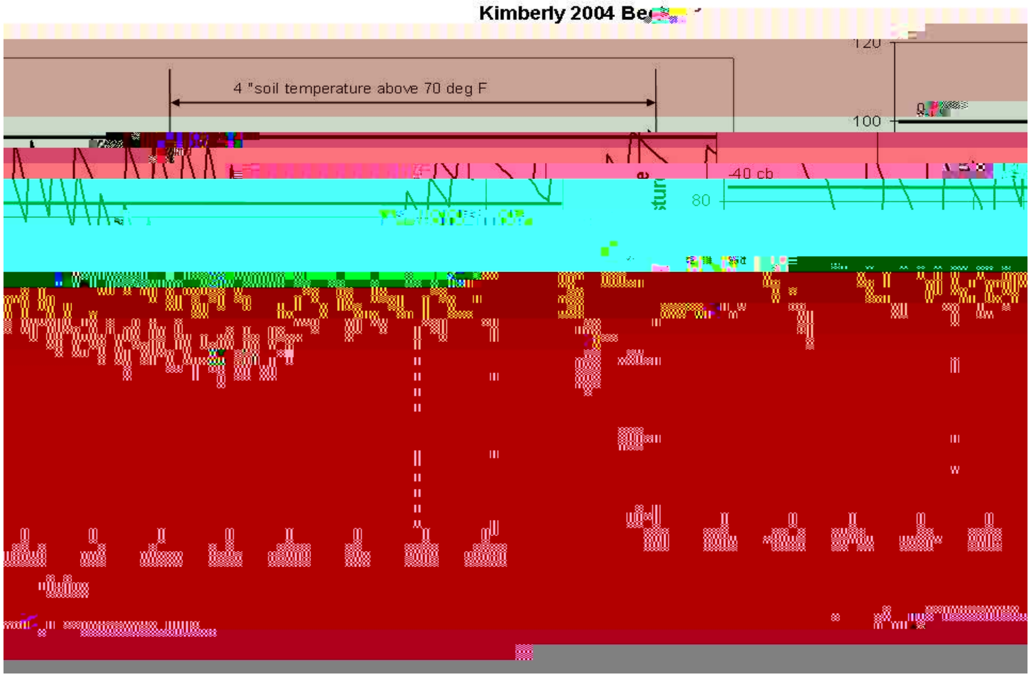


Figure 5. Seasonal variation in crop root zone soil moisture for a 7 gpm/ac center pivot operating under early season initially dry and moist soil moisture conditions.

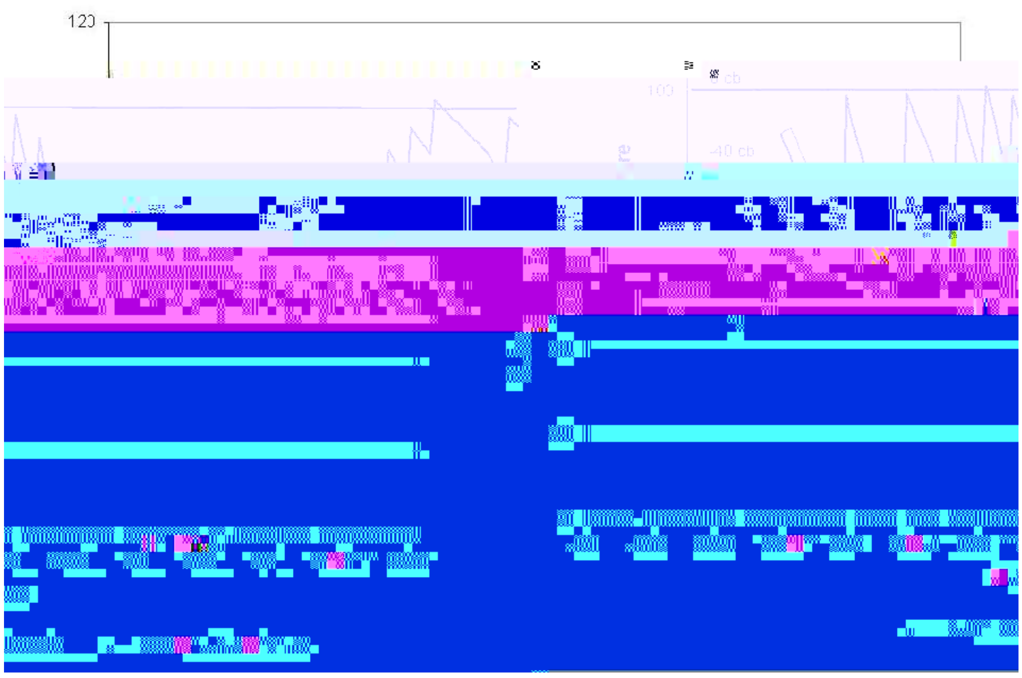
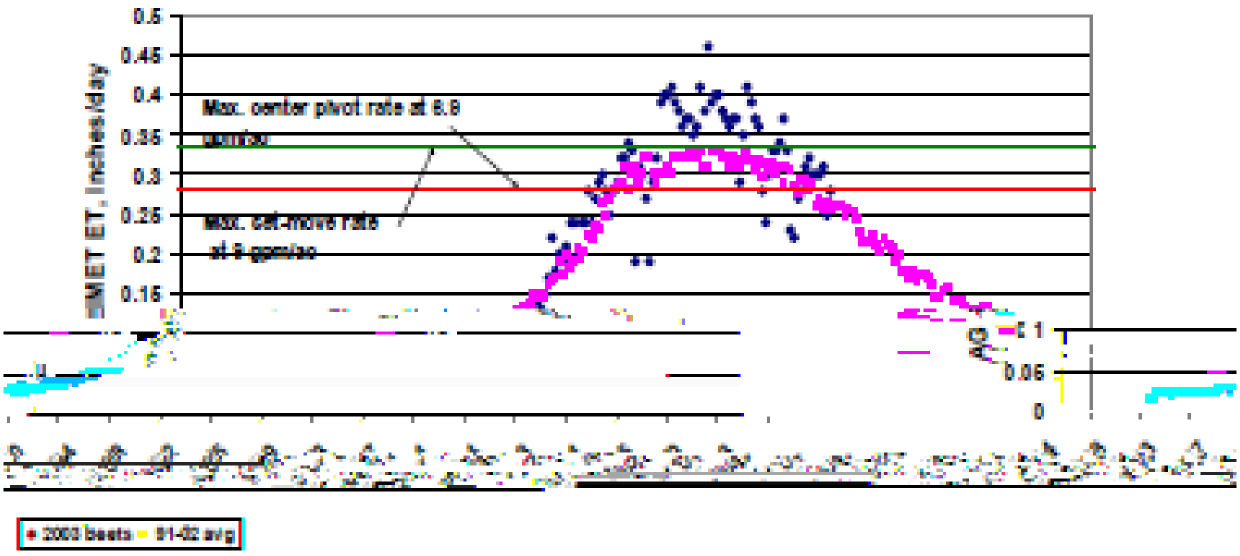


Figure 6. Seasonal variation in crop root zone soil moisture for a 7 gpm/ac center pivot operating under early season initially dry and moist soil moisture conditions. For a moist root zone, the pivot could be operated to maintain average soil moisture in the 50-70 cb range.



AGRIMET estimated ET for sugarbeets at

Figure 7. 10-year average and 2003

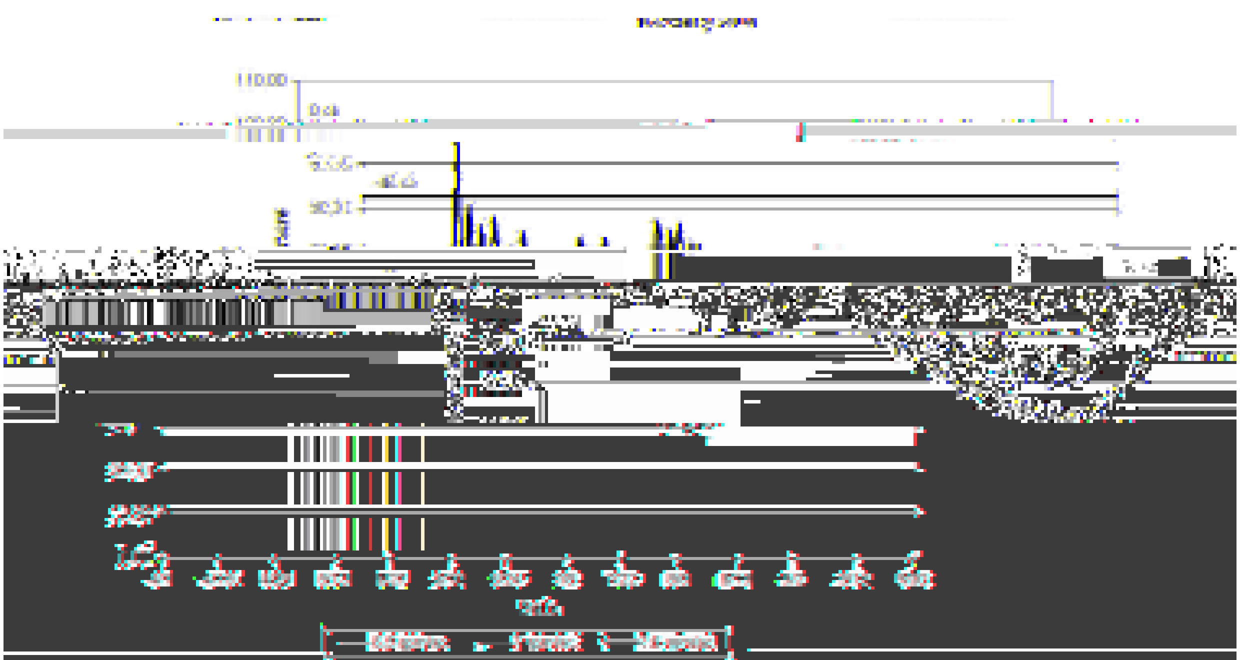
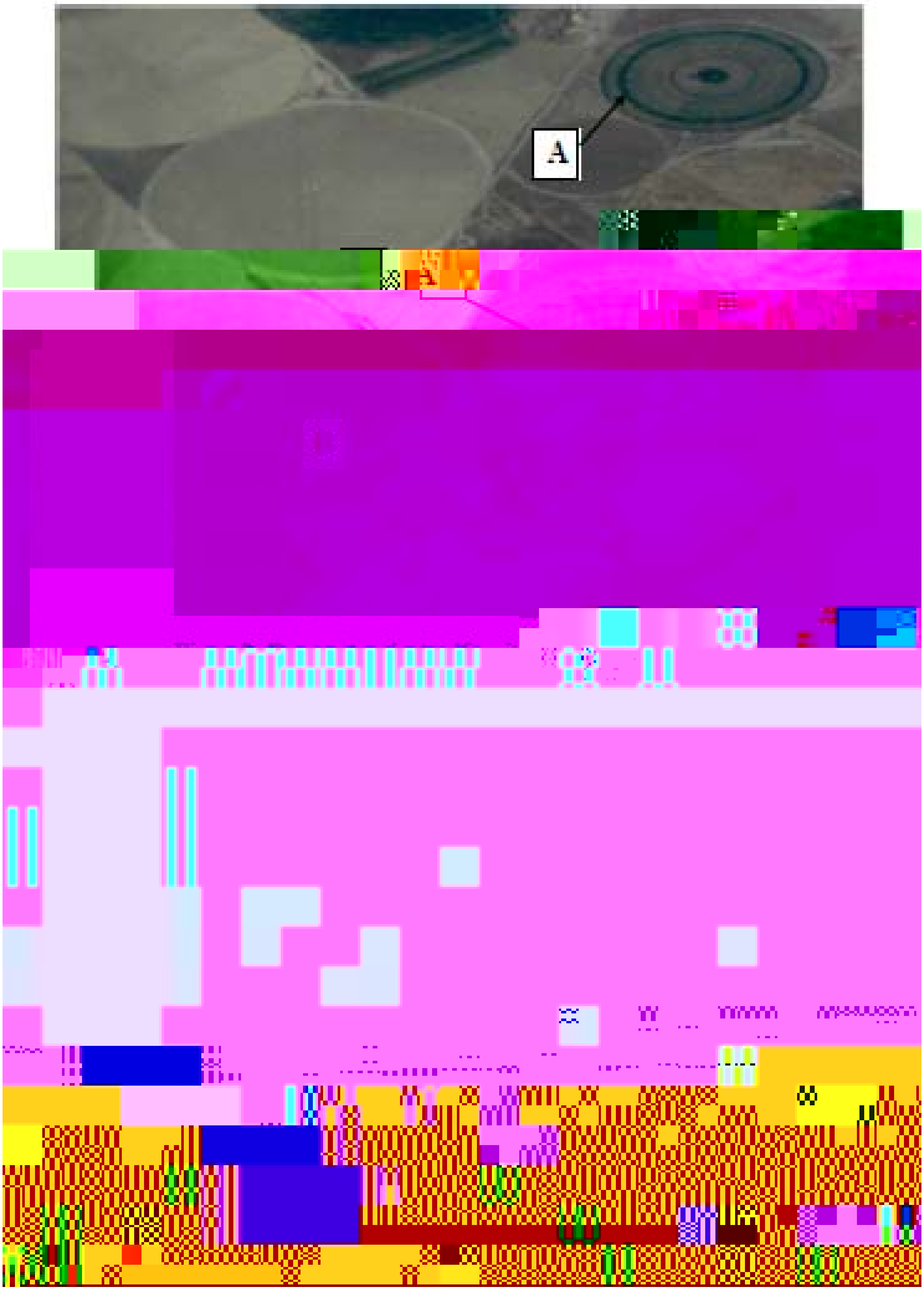


Figure 8. Seasonal variation in soil moisture for center pivot design capacities of 6.5, 7.0,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