

Deficit Irrigation; Managing a Potato Crop with Less Water

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Irrigation is required for profitable commercial potato production in the western U.S. Potatoes have a relatively shallow root zone and a lower tolerance for water stress than most other crops grown in Idaho. The preference for producing this drought sensitive crop in coarse-textured soils with limited water holding capacity makes precise irrigation management a necessity to obtain optimum yield and quality. When restricted water availability reduces potato production potential, options for increasing water use efficiency need to be considered.

The first step in optimizing the efficiency of any irrigation management program is to make sure the irrigation system is designed, maintained, and managed properly. Increasing irrigation efficiency to derive the most crop yield from every increment of water available will generally produce greater economic return than any other change in management. Irrigation scheduling and irrigation uniformity are two key management factors affecting irrigation efficiency. Irrigation scheduling involves determining the correct timing and amount of water necessary to maintain root zone moisture within the optimal range for crop growth. Irrigation uniformity is related to how evenly water is distributed over the field area.

An additional course of action is to evaluate possibilities for increasing the amount of available water per acre of potatoes produced. Potential courses of action include purchasing additional water from surrounding water users, selecting other crops that are drought tolerant or reducing acreage of other crops and transferring the water to the potato crop, and reducing or eliminating potato acreage.

Research has shown that potato tuber yield and quality will be impacted by even short periods of water stress. The extent of the damage to tuber yield and quality will depend upon the severity, timing, and duration of water stress during the growing season. Several studies have shown that water stress during the tuber set and early bulking growth stages causes the greatest reductions in tuber yield and quality relative to other growth stages. Water deficits spread over the latter part of the growing season generally have less impact on tuber yield and quality than an equivalent reduction in crop water use over a shorter period of time.

Nitrogen Fertilization. If deficit irrigation management is going to be implemented, the nitrogen management plan needs to be adjusted accordingly. The degree of yield response to nitrogen fertilizer decreases markedly as crop water use is reduced by water stress. Specific gravity is also greatly affected by water and nitrogen management. Specific gravity generally decreases when water stress and high N application rates are combined. High nitrogen availability during late tuber bulking also often delays tuber maturity. However, these effects are dependent on duration and amount of nitrogen and water availability, location, environment, variety, and other

stresses on the crop. Research in Idaho has shown that for every 15 to 20 percent reduction in water application from the optimum amount during the growing season, nitrogen requirements for maximum yield decline by 40 lb N per acre. Applying large amounts of pre-plant nitrogen should also be avoided since it likely will delay tuber bulking and make the impact of late season water stress more pronounced.

Management strategies for dealing with water shortages are relatively limited and are often controlled by decisions made at the irrigation or water district level. However, producers can partially mitigate these effects by preparing for anticipated water shortages before the crop is planted. In addition to deficit irrigation management, producers should also consider changing other cultural practices under their control, including extent of potato acreage, field choice, variety selection, and seed condition and spacing.

Field Choice. If possible, potatoes should be grown on fields that have the greatest potential for maintaining adequate soil moisture under deficit irrigation management. Coarse-textured soils such as sands and sandy loams have low water-holding capacities and will lead to rapid development of water stress under deficit irrigation. In comparison, soils with relatively high water-holding capacities, such as loams and silt loams, allow water stress to develop at a slower rate, reducing its impact on yield and quality

Variety. Variety choice can be an important tool in dealing with irrigation water deficits. Potato varieties vary widely in maturity and in ability to withstand water stress. One or both of these traits can help with avoidance of serious losses in short water situations. Planting an early maturing variety can help a grower avoid crop damage resulting from a late-season loss of water supply. Planting a drought resistant variety will minimize losses caused by any condition imposed by water shortage.

Varietal differences in drought resistance are illustrated by results of a recent study wherein potato varieties were exposed to five different water deficit scenarios. Treatments included 1) application of irrigation water to provide 100% ET replacement for the full season, 2) providing 100% ET replacement until Aug 10 with no application thereafter, 3) providing 75% of ET replacement for the full season, 4) providing 75% of ET replacement until Aug 10 with no application thereafter, or 5) providing 100% of ET replacement until July 20 with a reduction to 75% of ET until Aug 10 and then decreasing to 50% ET replacement until vine kill.

Results of this study show that providing full irrigation through mid-bulking, followed by a slow reduction in irrigation amounts was the best scenario, in a water short situation. Second, a late maturing, stress susceptible variety like Russet Burbank, is subject to large losses of marketable tubers under either moderate season-long stress, or sudden severe water stress caused by termination of irrigation. Third, an early maturing variety like Russet Norkotah can withstand late season loss of water with little or no loss of yield as long as there is sufficient water during tuber bulking. Fourth, a variety like GemStar Russet, although affected by water deficits, can maintain high yields of marketable tubers, even under fairly severe stress. Results from this same study show that

even varieties within a similar maturity class are affected differently by water stress. Alturas, for example, is a late maturing variety like Russet Burbank and Ranger Russet, but is even more affected by late season loss of water supply. This is likely due to a high water demand late-season, and its tendency for late tuber bulking. Below is a limited list of current varieties that may be used in deficit seasons.

Early Maturing Varieties

Russet Norkotah

Shepody (on early delivery contract)

Ranger Russet (on early delivery contract)

Many red varieties including Red Norland, Red LaSoda, NorDonna, Mazama, Modoc

Drought Tolerant Varieties

Russet Norkotah

Ranger Russet

GemStar Russet

Gem Russet

CalWhite

Seed Condition and Spacing. Physiological aging of potato seed often results in earlier plant emergence and tuber development. If water shortages are anticipated late in the season, accelerating tuber development by planting seed that has been aged by warming during storage may be advantageous. This may reduce the magnitude of yield reduction from early irrigation cutoff by completing more of the tuber bulking growth stage before water stress develops. Seed piece spacing can also be modified to partially mitigate the effects of water stress on tuber yield and quality during tuber bulking stress.

Summary. Potato production under deficit irrigation is not economically justifiable under normal conditions. However, under regional drought conditions, it may sometimes be unavoidable. Timing of water stress is important in order to maximize yield and quality under restricted water availability. Spreading water deficits over the latter part of the season will result in the least reduction in tuber yield and quality. Unfortunately, decisions made at the irrigation district level may limit the flexibility of deficit irrigation management. If possible, irrigation deficits should be avoided during tuber initiation and mid-bulking. Modification of irrigation, variety selection, fertility, and cultural management practices according to anticipated water availability can partially mitigate tuber yield and quality reductions.