Irrigation Best Management Practices for Potato

Clinton C. Shock1*, Andre B. Pereira2, and Eric P. Eldridge3

1Malheur Experiment Station, Oregon State University, 595 Onion Ave., Ontario, OR 97914
2Dept of Soil Science and Agricultural Engineering, State University of Ponta Grossa, 4748 Carlos Cavalcanti Ave., Ponta Grossa, PR Brazil 84030-970
3Malheur Experiment Station, Oregon State University, 595 Onion Ave., Ontario, OR 97914
*Corresponding author, Tel: (541) 889-2174, Fax: (541) 889-7831 Email: clinton.shock@oregonstate.edu

ABSTRACT

Application of the principle of best management practices (BMPs) for potato irrigation maximizes economic use of resources while minimizing environmental disturbances. Potato is a shallow-rooted crop that responds negatively to variations in water supply. Reported research confirms the detrimental effects of small errors in irrigation management on potato production profitability. Potato water use has been thoroughly documented in the literature. Newer irrigation application and control technology is available to growers. Irrigation BMPs for scheduling irrigation by crop evapotranspiration (ETc) and soil water tension (SWT) are presented and discussed. In most cases only refinements of existing potato irrigation systems are needed; growers need to acquire some way to measure ETc or soil water, or preferably both, along with record keeping to track irrigation, ETc, and soil water. An increased increment of management applied to potato irrigation can return greater profits to potato growers while enhancing the sustainability of production by avoiding environmental degradation.

RESUMEN

La aplicación de prácticas de un mejor manejo (BMPs) del riego para el cultivo de papa, maximiza el uso económico de recursos mientras que minimiza las alteraciones del medio ambiente. La papa es un cultivo de raíces poco profundas que responde negativamente a la variación en el abastecimiento de agua. Informes de investigación confirman el efecto nocivo de pequeños errores en el manejo del riego sobre la producción de papa. El uso de agua por el cultivo de papa ha sido ampliamente documentado en la literatura. La más reciente tecnología de aplicación y control del riego está disponible para los que cultivan papa. Se presentan y discuten las BMPs para programar el riego por evapotranspiración del cultivo (ETc) y tensión de agua del suelo (SWT). En la mayoría de los casos sólo se necesita un afinamiento de los sistemas de riego ya existentes; los que cultivan papa necesitan tener la forma de medir la ETc o el agua del suelo o preferiblemente ambos, junto con los registros para rastrear el agua de riego, ETc, y agua del suelo. Un mayor incremento en el manejo del riego en la papa puede rendir mayores beneficios, a la vez que la sostenibilidad de la producción mejora evitando la degradación del medio ambiente.

INTRODUCTION

Best management practices (BMPs) are production practices that help growers realize cost effective crop performance and protect soil and water resources. Irrigation BMPs must be sound from both environmental and economic perspectives. Movement of water through the soil profile can carry nutrients and chemicals to groundwater. Runoff from potato fields can carry soil, nutrients, and chemicals to streams, reservoirs, and lakes. One goal of research is to provide information that can be used to develop irrigation guidelines to minimize water movement of sediment, nutrients, and chemical residues to surface or ground waters. The research foundation of potato irrigation BMPs involves determining the optimum management of irrigation to meet potato water requirements without wasting water, soil, or nutrient resources.
These BMPs are generally defined as economically sound, yet practices that are capable of optimizing production by maximizing nutrient contamination of surface and groundwater. This review is intended to complement previous reviews of potato irrigation by Wright and Stark (1990) and Cappaert et al. (2007).

Potato is often considered to be a high water use crop, in fact many other crops grown in the same production zone have equal or greater seasonal water use requirements (Epstein and Shock 2006). Potato, however, is more sensitive to water stress than many other crops, have a relatively shallow root zone depth and are often grown on soils with low to moderate water-holding capacities. The shallow potato root system (Corey and Blake 1953; Durrant et al. 1973; Fulton 1970) results in more frequent irrigation than many other crops. Potato leaves also close their stomata at relatively small soil water stress compared to many other crops (Wright and Stark, 1990). Thus, soil water stress influences various physiological activities affecting the tuber yield and quality. Small variations in irrigation management and availability of nutrients affected flow of water (i.e., N, K, Ca, and B) can significantly influence tuber yield, size, grade, and internal and external quality.

Potato yield, grade, and internal quality can be reduced by over- or under-irrigation. Small deviations from optimum water application throughout the growing season can result in yield loss (Shock et al. 1998). Yield sensitivity to under-irrigation is attributable to the combination of sensitivity of the potato plant to water stress and shallow rooting resulting in limited soil water storage. Yield reductions due to over-irrigation may occur due to poor soil aeration, increased disease problems, and leaching of nutrients from the shallow root zone. Efficient irrigation management can increase marketable yield while reducing production costs by conserving water, energy, and soil mobile nutrients, as well as reducing the risk of potential groundwater contamination. Extensive research conducted at many locations provides useful guidelines for potato irrigation.

THE RESEARCH RESULTS

**Detrimental Effects of Water Stress**

Research shows us that there are very clear negative consequences of under-irrigation of potato, including losses in potato yield, grade, internal quality, and inefficient use of crop inputs. Tuber Set: Potato tuber response to soil moisture conditions begins before tuber set. Increased duration of water stress before tuber initiation reduces tuber set per stem (MacKerron and Jefferies 1986). Reduced tuber set in the Trinity Valley of Oregon and Idaho is related to the duration of soil water tension (SWT) drier than 60 kPa before and during the beginning of tuber set (Shock et al. 1992). Where Verticillium wilt is present, wilt can be reduced and tuber grade can be improved by keeping soils slightly drier early in the season before tuber initiation (Cappaert et al. 1994; Shock et al. 1992). In this case, the irrigation criterion before tuber set should be slightly drier than the local standard criterion used during tuber set and tuber bulking.

**Yield and Grade**: Loss of both yield and grade result from potato tuber sensitivity to fluctuations in water that stress the potato plant. The proportion of misshapen tubers is directly related to drier SWT (Corey and Myers 1955). A single transient SWT stress drier than 50 kPa increases misshapen ‘Russet Burbank’ tubers (Eldredge et al. 1992). Potato yield and grade are diminished by relatively mild water stress. Potato plants in Maine begin to experience water stress when SWT rises to 25 kPa (Epstein and Grant 1973). With furrow and sprinkler irrigation, reductions in water applications on silt loam to a SWT drier than 60 kPa during tuber bulking result in yield reduction and loss of economic return in Oregon (Eldredge et al. 1992; Shock et al. 1993). ‘Umatilla Russet’ yields are reduced on silt loam using an automated drip irrigation system with criteria drier than 50 kPa (Shock et al. 2002). The 30 kPa irrigation criterion is wetter than the 50-60 kPa criteria for sprinkler and furrow irrigation of potato at the same site; the drip irrigation events add small amounts of water more frequently, resulting in lower water fluctuations in the drip-irrigated potato. Irrigation deficits occurring during mid- and late-season tuber bulking are particularly damaging to yield (Miller and Martin 1987). In a comparison of six potato varieties, Oregon researchers showed that some varieties are more sensitive to water stress, resulting in total yield or grade losses greater than for other varieties (Shock et al. 2003a). Russet Burbank is more sensitive than the ‘Butte’ variety in forming misshapen tubers under water stress (Kleinkopf 1979).

**Internal Quality**: Tuber physiological disorders such as brown center, hollow heart, and translucent end, as well as secondary growth, growth cracks, bruise susceptibility, and heat necrosis have been associated with water stress and/or wide variations in soil moisture content (Eldredge et al. 1992,