IRRIGATION AND NUTRIENTS REQUIRED BY RUSSET BURBANK POTATO FROM MID TO LATE SEASON

by
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A preliminary report was issued on water and fertilizer management for potato (4). Additional knowledge has been obtained since that time. Both moisture and nutrient stress, particularly N, can cause serious production problems.

These stress factors during tuber development may alter the shape and size distribution of tubers with a drastic reduction in market grade. There is added concern that stress factors may be partially responsible for internal physiological disorders like hollow heart (HH), brown center (BC) and internal brown spot (IBS).

Hiller's group demonstrated that BC was induced by cool soil temperature at tuber formation or low temperature combined with high soil water content (6). Early season (mid-May to mid-June) water stress had no consistent effect on physiological internal HH or BC disorder of tubers. Water stress during July and the rest of the season decreased IBS. Irrigation treatments alone had no consistent influence on degree of HH and BC.

The purpose of this report was to review some previous results and present some additional information on irrigation and N nutrition of potato. The objective of our experiments discussed in this report was to determine the effect of moisture gradient irrigation treatments established by a line source sprinkler on crop yield and N uptake by Russet Burbank potato. Irrigation treatments were applied from the first of August to the end of the season.

Procedure

Experiments were conducted with Russet Burbank potato at WSU-Prosser in 1987 on Warden silt loam, and at the WSU Othello research unit in 1988 on Shano silt loam. Plantings were around the end of April. Replicated N treatments were broadcast over the rows in 20 ft plots at rates of 200, 300 and 500 lb/a as ammonium nitrate, with equal split applications at planting, in June and July. Results from the intermediate N rate are reported here.

Irrigation was maintained at optimum with solid-set sprinklers (40 x 40 ft) up to the first of August when line source sprinklers were used the rest of the season.

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The irrigation treatment required applying water equivalent to the accumulated ET every other day at the center line with water tapering off to deficit irrigation at the borders the rest of the season. Catch-cans were used to measure applied water on individual rows.

Samples of plant tops and tubers were taken the end of August with tuber samples also taken at harvest September 1987 and October 1988. Tuber samples were diced, and then dried, weighed and analyzed for total N like samples of tops. Total yield, U.S. No. 1's and specific gravity were determined at harvest. Tubers were also sliced and examined for BC, HH and IBS.

Irrigation and Nitrogen

Potato cultivars differ substantially in stress tolerance to limiting moisture. Precise crop factors are not always available to make the appropriate adjustments in the estimated evapotranspiration (ET) derived from pan evaporation as in Fig. 1. Results in Fig. 1 were obtained in conjunction with potato experiments earlier where an average of 62% of the season total irrigation required had been applied and 72% of the seasonal pan evaporation had been recorded by the end of July (1). Interrupting irrigation during tuber bulking or increasing water stress the last 8 to 10 weeks of the season made most Russet Burbank tubers unsalable but Lemhi and Nooksack were only slightly affected (2). During the last 10 to 12 weeks before potato harvest, the crop can use soil moisture to compensate for 20 to 30% of the ET replacement in sandy soil and up to 60 to 80% in a loam soil (2).

Maturing plants are believed more stress-tolerant than younger plants. If the soil becomes too dry approaching harvest, harvesting may be difficult. At the start of the season before full crop cover, the pan evaporation usually exceeds the irrigation water requirement (Fig. 1). Later, after full cover the estimated ET more closely relates numerically to pan evaporation.

The relative amount of N taken up in tubers and whole plants (vines +tubers) as a percent of total was expressed in Fig. 2 as adapted from anotherstudy (5). At the end of July, about 82% on average of the N had been taken up in whole plants following application of 300 lb N/a.

Potato yields are shown for line source irrigation treatments applied from August until the end of the 1987 and 1988 seasons (Fig. 3,4). Soil moisture content was high at the time irrigation treatments were initiated. In both experiments, there was a trend toward increased yield near the irrigation rate of 100% ET. In 1987, the yield increase with increased irrigation rate from 50% to 100% ET was about 2 t/a (Fig. 3). In 1988 potato yield peaked with irrigation rate between 75% and 100% ET (Fig. 4). The yield of U.S. No. 1 tubers followed the pattern of total yield and peaked at irrigation rate of 100% or slightly less.

Total N uptake (Fig. 5) followed a trend toward increased N uptake with additional water along with the pattern of tuber yield. Specific gravity of tubers showed no definite trend with most values clustered around 1.080.

The primary internal defect noted was hollow heart. The observed internal defects were highly variable. High incidence of hollow heart has been reported with a combination of soil moisture content at 80% to 90% available water combined with three, equal 30-lb weekly N applications just after tuber initiation (3). There were a few cases in the present experiments which had up to 20% HH mostly at high irrigation rates. Improved techniques are needed to study internal defects.

References

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Figure 1. Total evaporation and irrigation for potato experiments averaged over two years showing the relative distribution through the season (1).

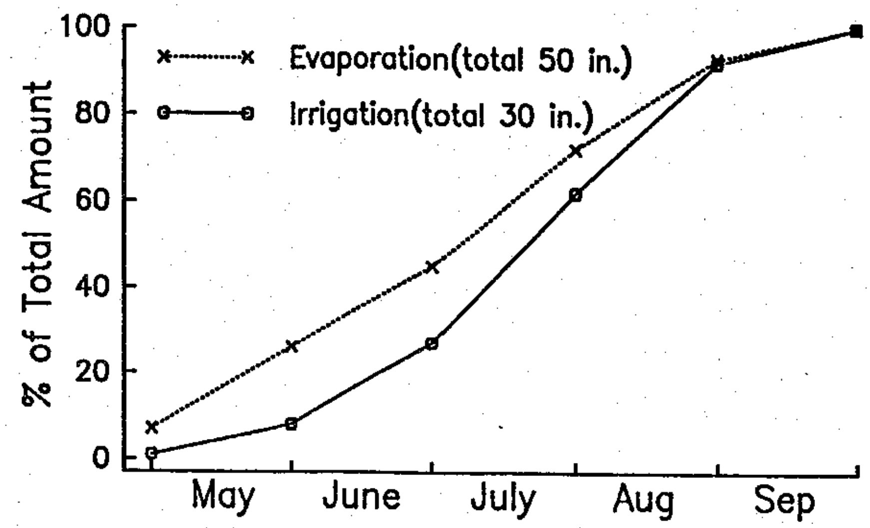

Figure 2. Percent of total N uptake in tubers and whole potato plants averaged over 5 years with annual applications of 300 lb N/a with N in whole plants at the end of August taken at 100% (5).

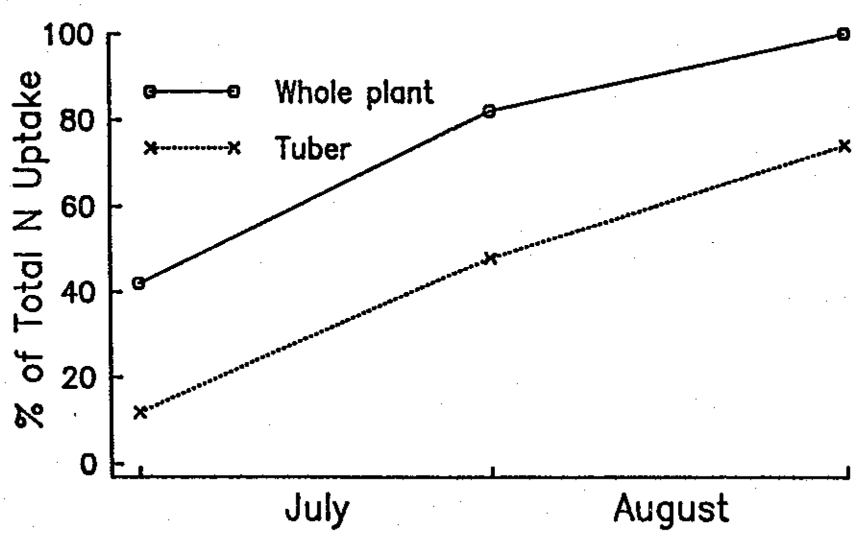

Figure 3. Yield of potato (1987) grown with seasonal optimum irrigation except from the beginning of August to mid-September when line source irrigation treatments were applied to give a moisture gradient from less than 50% to more than 100% of estimated ET (four replications).

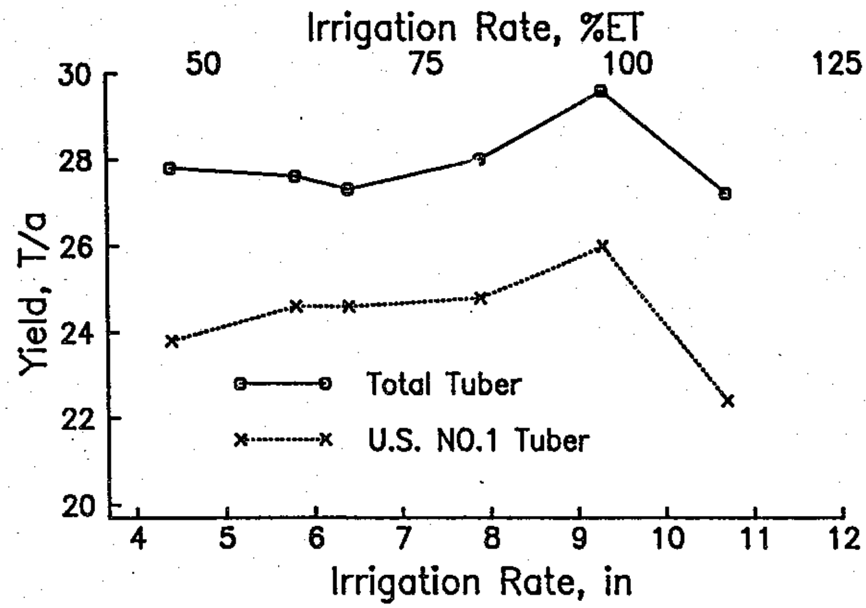

Figure 4. Yield of potato (1988) grown with seasonal optimum irrigation except from the beginning of August to mid-October when line source irrigation treatments were applied to give a moisture gradient from less than 50% to more than 100% of estimated ET (four replications).

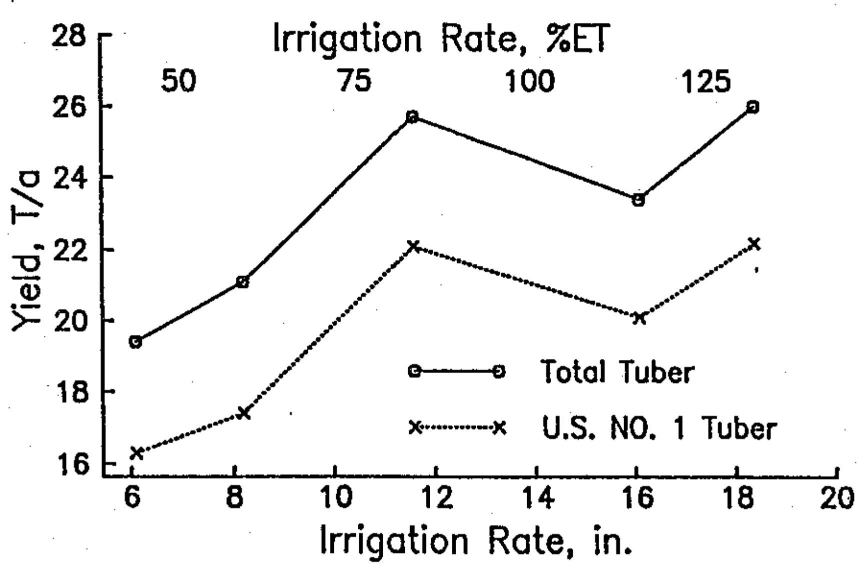

Figure 5. Total N uptake in tubers and whole plants (vines + tubers) at the end of August 1987 with irrigation rates (inches) and ET values equivalent to Fig. 3.