RUSSET BURBANK YIELD RESPONSE TO SPRINKLER-APPLIED NITROGEN FERTILIZER

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Abstract

Yield response curves were developed for potatoes (Solanum tuberosum cv. Russet Burbank) with sprinkler-applied N fertilizer on a high-frequency schedule. The potatoes were grown on a Quincy sand to loamy sand (mixed, mesic, Xeric Torripsamments) typical of sandy-textured soils of the center-pivot irrigated areas of the Columbia River Basin of Oregon and Washington. These soils require daily irrigation at peak evapotranspiration because of low water-holding capacity. Yields were measured for total quantities of N, ranging from 100 to 665 kg N/ha, applied in small frequent increments as a urea-NH4NO3 solution. Maximum tuber yields ranged from 67 to 85 Mg/ha in 6 experiments over a period of 6 years. Economically optimum yields were obtained at fertilizer rates between 300 and 400 kg N/ha depending on cost-price ratio of N fertilizer and potatoes. Fertilization in this range should optimize tuber yield and quality with fertilizer N efficiency and economic return on fertilizer investment.

Resumen

Se desarrollaron curvas de rendimiento para papas (Solanum tuberosum cv. Russet Burbank) como respuesta a la aplicación, por aspersión, de fertilizante nitrogenado, en un programa de alta frecuencia. Las papas fueron cultivadas en arena o migajón arenoso Quincy (mezclado, mesic, Xeric Torripsamments) típico de los suelos con textura arenosa de las áreas irrigadas centrales de la cuenca del río Columbia de Oregón y Washington. Estos suelos requieren ser irrigados diariamente a máxima evapotranspiración debido a su baja capacidad de retentividad de agua. Los rendimientos fueron medidos para las cantidades totales de N, variando de 100 a 665 kg N/ha, aplicados en incrementos frecuentes y pequeños como una solución de urea—NH4NO3. El máximo de los rendimientos en tubérculos varió de 67 a 85 Mg/ha en 6 experimentos en un período de 6 años. Económicamente, se obtuvieron rendimientos óptimos con cantidades de fertilizante entre 300

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Applying water and nitrogen fertilizer together on a high-frequency schedule, known as "nitrogation" or "fertigation," is a common practice on potatoes grown on sandy-textured soils (8, 9, 10). A quantity of nitrogen is usually applied before or at planting with additional applications made in small frequent increments in the irrigation water during the growing season. This split-application approach does not consistently result in improved potato tuber yield or quality compared to all preplant N fertilization, because careful irrigation scheduling can minimize N leaching (8, 9). However, Kleinkopf and Westermann (3) recommend a low N application at planting with supplemental applications later to promote early tuber growth and to increase fertilizer N efficiency. In Wisconsin on a loamy sand soil, increasing the frequency of irrigation and N fertilization increased fertilizer use efficiency by 35% over more conventional scheduling (10).

Low N fertilization during the early plant growth stages followed by higher N applications during more rapid growth stages should increase fertilizer N use efficiency. When all fertilizer N is applied before crop emergence, there is a high probability of N leaching because of low requirements for water and N in early growth stages. Low N applications on young plants more nearly matches their N needs, as well as decreases N susceptible to leaching. Finally, most of the plant N requirements can be supplied by frequent applications during the rapid growth period.

Excessive N applications and irrigation have been justified on potatoes to minimize the risk of decreasing yield of marketable tubers (4). Excess irrigation is most probable during early plant growth and post-maturity senescence when canopy cover is incomplete. Excessive N and water applications, limited rooting depth on sandy-textured soils, and nonuniform water infiltration under potato plant canopies promote N leaching losses and decreased recovery of N fertilizer (7, 11, 12, 13).

Yield response functions are needed to evaluate high-frequency sprinkler-applied N fertilization of potatoes. Economic analyses can be made from these functions. The functions also can be used to design experiments to evaluate other variables such as N fertilizer timing or N and irrigation interactions with assurance that N treatment rates are reasonable. Experiments were done to determine yield response functions with frequent sprinkler-applied N fertilization.