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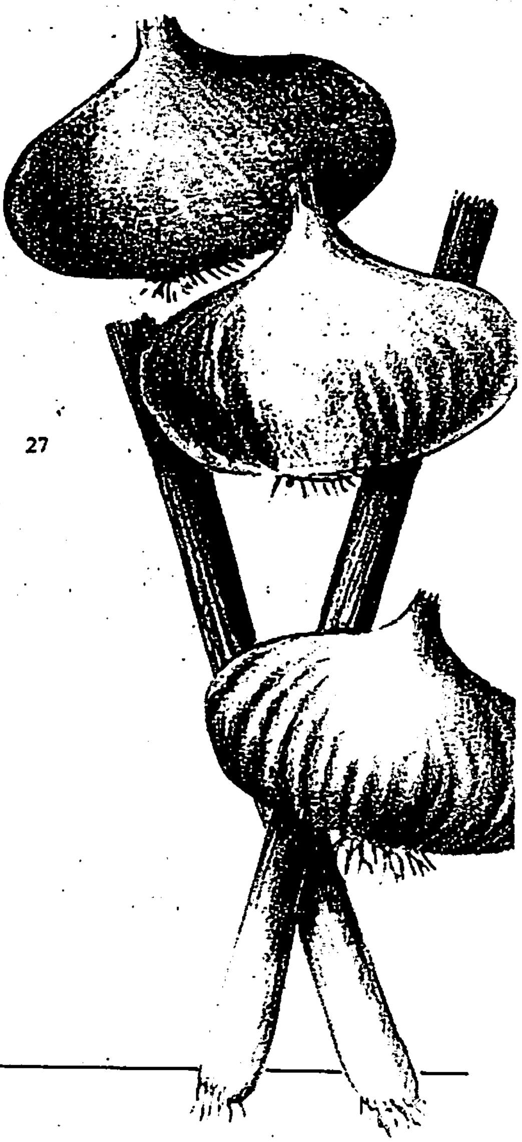

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EFFECT OF IRRIGATION RATE ON NUTRIENT ACCUMULATION AND YIELD OF 'YELLOW GRANEX' ONIONS

by

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Onions (Allium cepa L, cv Yellow Granex) grown at upper elevations in Hawaii command a premium price. The Volcano Experiment Station is located at an elevation of 1200 m and received 159 cm of rainfall between the date seedlings were transplanted in this experiment (November 6, 1987) and April 13, 1988 when they were harvested. The onions were grown in a plastic-covered rain shelter with 0.6-m high open sidewalls.

Two-month-old seedlings were transplanted into the Manu silt loam soil in 4-row bedded plots with a 15-cm spacing between plants and 23 cm between rows. Plants were watered daily from the transplanting date until 42 days before harvest via two lines of 'Drip-In 2L' irrigation tubing (30-cm emitter spacing) per plot. The total amounts of water applied during the crop were 8, 35, 67, 140 and 247 liters (L) per meter of row. In addition, sub-surface movement of water contributed to the supply of available moisture by unknown amounts. A pre-plant fertilizer application consisted of, in kg/ha, 16-16-16 (1150), dolomite (2800), treble super phosphate (300) and KMag (300). A side-dressing of calcium nitrate solution (100 kg/ha) was applied 10 days after transplanting.

Total saleable onion yield and yield of the largest bulbs (greater than 10 cm in diameter) were 2.3- and 4.6-fold greater, respectively, in plots that received 140 L of water per meter of row as compared to those receiving 8 L (Figs 1 and 2). When the amount of water applied was raised to 247 L/m of row, however, the total and largest-bulb yields decreased by 24 percent and 59 percent, respectively, compared to the yields in plots receiving 140 L of water/m of row.

The yield of smaller onions (less than 10 cm diameter) was much greater in those plots that received 8 L/m of row, compared to those receiving 140 L of water/m (Fig. 1). However, there was a tendency for these yields to increase again at the highest rate of water application; i.e., 247 L/m of row. Increased water application did increase the number of split bulbs, though. For example, the yield of split onions increased 16-fold, from 0.07 kg/m of row at 8 L of water to 1.23 kg/m at 247 L.

Tissue nutrient concentrations were also monitored as functions of the amount of water applied (Table 1). The most recently-matured leaf (leaf number 3 when the newly-emerging leaf is designated as number 1) was sampled for analysis 84 days after transplanting. The leaf nitrogen content decreased by 27 percent in plants receiving 247 L of water compared to those with 8 L but the greatest decrease (25 percent) occurred when the rate of water application was raised from 140 to 247 L. Tissue potassium levels showed a similar pattern with no significant effect when the water application rate was 140 L/m of row and below. However, the tissue K level did decrease by 9 percent at the highest rate of water application. Tissue concentrations of phosphorus and magnesium were unaffected by water availability over the range tested.

Plant tissue samples were also taken 115 days after transplanting. The responses described above for N, P, K and Mg were repeated. In addition, the tissue was analyzed for Fe, Zn, Cu and Mn (Table 1). Tissue Fe and Zn levels decreased by 29 and 22 percent, respectively, at 247 L of water compared to those at 140 L/m of row. There was no apparent effect of water availability on Cu uptake and accumulation in the plant tissues. The effects, if any, on Ca and Mn utilization were inconclusive.

Soil analyses for K, Ca and Mg were conducted after harvest to determine the effect of water application rate on nutrient retention (Table 2). The electrical conductivity of a saturated soil extract, and the soil K, Ca and Mg levels, decreased by 52, 54, 7 and 17 percent, respectively, in the 247-L plots compared to the 8-L ones.

In summary, the rate at which water is applied during an onion crop strongly affects both the total saleable yield and the size of the individual bulbs. Further, irrigation rates also influence availability, uptake and accumulation of nitrogen, and possibly of K, Ca, Mg, Fe, Zn and Mn. Thus, the rate of water application should be considered in planning fertilizer application rates and timing.

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Table 1. Nutrient concentrations in onion tissues as functions of irrigation rate. (Data for N, P, K, Ca and Mg obtained from plants 84 days after transplanting; Fe, Zn, Mn and Cu data obtained 115 days after transplanting.)

Rate, L/m	N	P	K	Ca	Mg	Fe	Zn	Mn	Cu
	percent dry wt					µg/g dry wt			
8	3.03	0.30	3.02	0.50	0.28	90	40	183	5.3
35	2.97	0.32	2.89	0.55	0.29	101	40	297	5.0
67	3.20	0.34	3.03	0.56	0.30	94	40	282	5.5
140	2.93	0.32	2.98	0.51	0.27	90	32	209	5.5
247	2.20	0.32	2.75	0.46	0.27	64	25	178	5.5
LSD 5%	0.42	0.04	0.25	0.07	0.04	21	13	111	1.6

Table 2. Potassium, calcium and magnesium contents of soil and its electrical conductivity as a function of irrigation rate.

Rate, L/m	K	Ca	Mg	EC_e, mmole/cm
8	1313	3389	1109	2.3
35	1041	3331	1003	1.9
67	879	3193	934	1.3
140	722	3071	847	1.3
247	601	3150	810	1.1
LSD 5%	414	201	136	1.2

FIGURE 1. Onion yield by grade as a function of water applied.

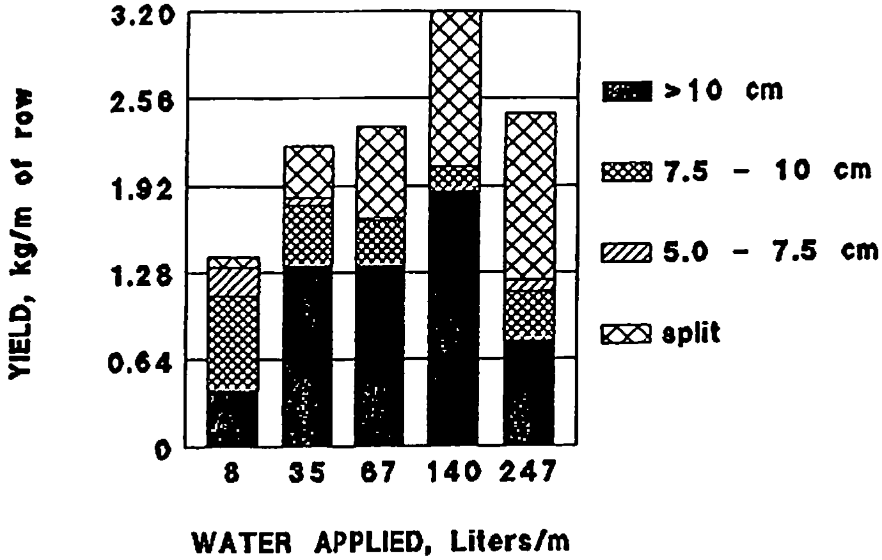

FIGURE 2. Grades of onions, as percent of total yield, as a function of water applied.