

# FERTIGATION FREQUENCY EFFECTS ON YIELD AND QUALITY OF SUBSURFACE DRIP-IRRIGATED BROCCOLI

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## **Abstract**

*Subsurface drip irrigated broccoli received experimental combinations of N rate (176 and 268 lb N/ac, and fertigation frequency (daily, weekly, bi-weekly, monthly) at the Maricopa Agricultural Center during winter 1998-99. Marketable broccoli yields were increased slightly with N applications of 268 lb/acre compared to 176 lb/acre. However, neither marketable yield, head diameter, nor petiole nitrate concentrations were significantly affected by fertigation frequency. Nitrogen fertigation frequency does not seem to be a critical management variable for subsurface drip irrigated broccoli grown on medium-textured soils in Arizona.*

## **Introduction**

Subsurface drip irrigation is an efficient means for applying water and nutrients to annual row crops. In general, at least 10-30% water savings can be realized compared to conventional surface irrigation systems. Therefore, increased adoption of subsurface drip irrigation and fertigation with fluid N sources will contribute to a sustainable future for crop production in the arid West, even though water supplies continue to diminish. Subsurface drip irrigation and fertigation with fluid N can result in optimum crop yield, quality, and economic return, without polluting losses of N to groundwater (Pier and Doerge, 1995; Thompson and Doerge, 1996).

Very frequent or continuous fertigation has often been recommended in the technical or popular literature (Bar-Yosef and Sagiv, 1982; Stark et al., 1983; Burt et al., 1995; Stephens, 1997). However, very few studies have shown a benefit of frequent or continuous fertigation compared to less frequent fertigation. Bar-Yosef and Sagiv (1982) advocated continuous fertigation of surface drip-irrigated tomatoes (*Lycopersicon esculentum* L.) with concentrations of 100 to 200 mg N/L in the applied irrigation water. However, this resulted in N applications in excess of 1000 kg N/ha, far greater than the N uptake by the plants, and may have resulted in large leaching losses of NO<sub>3</sub> below the root zone. Stark et al. (1983) determined that 75 mg N/L was the optimum concentration for continuous fertigation of tomatoes with surface drip irrigation. Bhella and Wilcox (1985) advocated continuous fertigation of surface drip-irrigated muskmelon (*Cucumis melo* L.) with 150 mg N/L and 50 mg N/L during vegetative and reproductive stages, respectively. Lahav and Kalmar (1988) reported that banana (*Musa cavendishii* Lamb.) yields with surface drip irrigation on a clay soil were not affected by continuous versus weekly fertigation events. Cook and Sanders (1991) examined the effect of fertigation frequency on tomato yields in a loamy sand soil. Daily or weekly fertigation significantly increased yield compared to less frequent fertigation, but there was no advantage of daily over weekly fertigation.

Locascio and Smajstrla (1995) found that tomato yields with daily fertigation were not increased over weekly fertigation events on a fine sand soil. Similarly, yields of drip-irrigated peppers (*Capsicum annum* L.) were not affected by fertigation interval (11 or 22 days) on a loamy sand soil (Neary et al., 1995).

In summary, while it is often assumed that continuous or daily fertigation is preferable to less frequent fertigation, there is scant evidence in the literature to support this viewpoint, even for drip-irrigated crops grown in sandy soils. Fertigation frequency is one major management variable with drip irrigation that has not been adequately investigated.

The objectives of this research are to i) determine the interactive effects of N rate and fluid N fertigation frequency on crop yield, quality, and in-season N status of a broccoli crop ii) estimate N losses below the root zone as affected by N rate and fluid N fertigation frequency, and iii) determine optimum fertigation frequency.

### **Materials and Methods**

This experiment was conducted during winter 1998-99 at the University of Arizona Maricopa Agricultural Center (MAC) in a field mapped as a Casa Grande sandy clay loam soil (25% clay). Before the cropping season, the experimental area was cropped in the summer with surface flood-irrigated sudangrass (*Sorghum sudanenses* L.) to remove available soil N and reduce field variability. Phosphorus as triple superphosphate granular fertilizer was broadcast before planting, and incorporated into the soil beds. Before broccoli planting, drip irrigation tubing (9 in. emitter spacing, delivering 0.5 gal/min/100 ft., from Chapin Watermatics, Watertown, NY) was buried 6 in. deep in raised soil beds 40 in. apart. Plot size was 30 ft. long by 4 beds wide.

Broccoli (var. »Marathon») was direct-seeded into dry soil on 10 Oct., 1998. Uniform irrigation was applied through the drip tubing in order to encourage germination and stand establishment. Approximately 12 in. of irrigation water were applied between planting and stand establishment (1-2 true leaf stage). After stand establishment, daily irrigations were initiated by an automatic controller. Irrigation amounts were scheduled based on feedback from tensiometers installed at 0.3 m depth within several plots. The target soil water tension was 10 cbar. Volumes of water applied were monitored by flow meters.

The experiment consisted of combinations of two N rates (176 and 268 lb N/ac) and four fertigation frequencies (daily, weekly, bi-weekly, and monthly). Fluid fertilizer (urea ammonium nitrate solution, 32% N) was injected directly into irrigation water using a proportioning pump. The temporal distribution of fertigations is shown in Fig. 1.

Petiole samples were collected bi-weekly, analyzed for NO<sub>3</sub>-N, and compared with published tissue test guidelines (Kubota et al., 1997) to determine plant N status. Broccoli heads from a 3m<sup>2</sup> area of each plot were harvested when mature, and graded for marketability. Dry matter and N accumulation were determined from 1 m<sup>2</sup> areas within each plot at harvest. The harvest period began on 10 February and ended on 22 February.

## Results and Discussion

Marketable yield of broccoli was 5-6 tons/acre, which is near the statewide average yield. Broccoli yields with fertilizer applications of 267 lb. N/acre were higher than those with 168 lb N/acre, but this increase was not statistically significant. There was no yield response to increasing fertigation frequency. If anything, yields were higher with biweekly and monthly fertigation at the highest N rate, compared to daily or weekly fertigation (Fig. 2). The daily fertigation amounts were intended to simulate the pattern of broccoli N uptake. Fertilizer N applied to the weekly, biweekly, and monthly fertigation treatments was always in advance of that applied to the daily fertigation treatment (Fig. 1). Broccoli head diameter was unaffected by either N rate or fertigation frequency.

Nitrate concentrations and petioles are shown in Fig. 3. Initially, concentrations for all treatments were high, and above the adequate concentration range. However, by the second sampling date concentrations in all treatments had decreased significantly, and remained low for the next 30 days. Overall, petiole nitrate concentrations were not greatly affected by N rate. Fertigation frequency also had no consistent effect on petiole nitrate concentrations.

## Conclusions

Subsurface drip irrigated broccoli received experimental combinations of N rate and fertigation frequency from daily to monthly. Marketable broccoli yields were increased slightly with N applications of 267 lb/acre compared to 168 lb/acre. However, neither marketable yield, head diameter, nor petiole nitrate concentrations showed any effect of fertigation frequency. Fertigation frequency does not seem to be a critical management variable for subsurface drip irrigated broccoli on medium-textured soils in Arizona. Two more identical experiments are planned for the coming winter seasons.

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