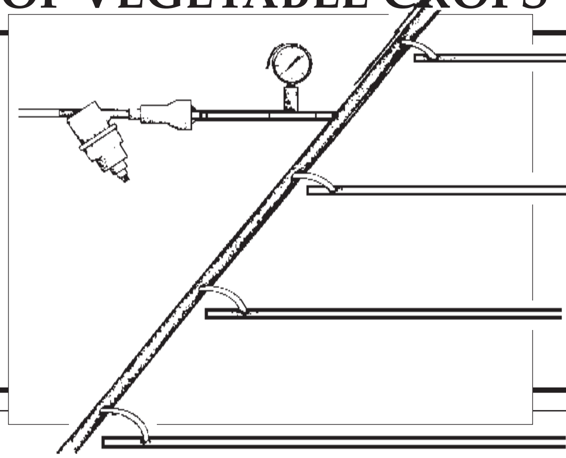
FERTIGATION
OF VEGETABLE CROPS



BY
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Drip irrigation used in conjunction with plastic mulches is becoming a standard practice for vegetable production in many areas of the country. Once a grower has installed a drip irrigation system, it makes economic and environmental sense to fertilize the crop via the system, as needed. This results in more efficient use of fertilizers and probably lessens fertilizer contamination through leaching below the plant root zone.

In its broadest sense, fertigation is "feeding" a vegetable crop by injecting **soluble** fertilizers into water in the irrigation system. To be more specific, drip fertigation can be used to refer to injecting soluble fertilizers into a drip irrigation system.

RULES OF FERTIGATION

A few rules should be followed, to achieve maximum benefit from fertigation.

- The fertilizer type used and amount required must be soluble enough to **dissolve completely** in the fertilizer tank water.
- The drip irrigation system needs to be **completely charged or pressurized** before fertigation begins. The farthest point from the pump should be at full pressure before injection of any fertilizer begins.
  If the system is not fully charged, air surges could occur and cause uneven application rates.
- The fertilizer should be **injected ahead of the filters** to ensure that any undissolved particles are filtered out before fertilizer enters the drip tape.
- The period of time in which fertilizer is injected into the system must be at least as long as that required to bring the entire drip irrigation system up to full pressure. This will allow each dispensing orifice in the drip line to have the same contact time with the fertilizer solution as it passes through the system.
- Any drip fertigation system should have an anti-siphon device, such as a vacuum breaker or backflow preventer, to protect the water supply. This usually is required by state law. If backflow prevention is not in place, fertilizer that remains in the system when it is shut down will siphon back through the pump and into the water source. All fertigation units should be wired to the pump switch or a flow control switch in the main line to prevent the unit from running when no water flows in the line.

SETTING UP A SYSTEM

Selecting an Injector

- *Venturi Bypass:* Water flowing through the venturi creates a suction that draws the fertilizer solution into the line. The "hozon" is the simplest type of venturi injector. Because of its small capacity, it is recommended only for areas of ½ acre or less. Other venturi units up to 2 inches in diameter are available. This injection method is inaccurate because pressure and flow rates vary in a drip irrigation system.
- *Metering Pumps:* These inject fertilizer directly into the line at a uniform rate. Small electric pumps can be used. Diaphragm pumps are more reliable than piston pumps, because the corrosive fertilizer solution does not contact any moving metal parts. Water-driven piston or diaphragm pumps, recent developments, draw a known volume of solution and force it into the irrigation line. These pumps are a real advantage in

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isolated areas without electricity. Commercially available units are the TMB pump by Bermad and injector pump by Amiad.

- *Hydraulic Units:* The "Dosatron," a water-driven proportional injection unit, was originally designed for industrial uses and injecting chlorine into city water supplies. Fertilizer from a tank is drawn into the injector pump as drive water pushes the pump piston upward. Once the piston reaches its highest point, a valve in the unit creates a pressure difference and reverses the flow of water, causing the piston to begin its downward movement. As the piston moves downward, the water that originally pushed the piston upward is injected with a dose of fertilizer and released into the main line of irrigation water. This system works while attached in-line and does not require a bypass, as do many other units.

Selecting a Fertilizer

Fertilizer materials vary in how much will dissolve in a given quantity of water. Water in which fertilizers are to be dissolved should have pH levels between 5.8 and 7.8. The solubilities of some common fertilizers used in drip fertigation are presented in Table 1.

To dissolve fertilizer materials having a low solubility, continuous agitation of the solution with a mechanical screw or recirculation pump may be necessary. Using warm water also increases the solubility of fertilizer.

The fertilizer material must be **completely dissolved**, so that each gallon of irrigation water contains the same amount of fertilizer. The greater the percentage of the fertilizer required for a given crop that is applied via fertigation, the more important proper mixing and uniformity of application becomes to prevent nonuniform crop growth.

To dissolve the fertilizer, it is best to fill the nurse tank one-half full of water, then add the fertilizer material and remaining water while constantly agitating the solution. If fertilizer settles out on the bottom of the tank, it is being added too quickly.

Some unusual reactions can take place. Potassium nitrate or ammonium nitrate cause the solution to become cold as the material dissolves, which means that less material can be dissolved without using heat.

We recommend that a fertilizer solution be allowed to settle prior to pumping into the system. Usually, settling overnight allows adequate clearing time for most fertilizer solutions.

The point at which the fertilizer solution is drawn from the tank should be above the bottom, usually 12 to 18 inches. This will allow enough room for impurities to settle out. Any undissolved materials usually can be removed or cleaned out of the bottom of the tank.

Some fertilizers, such as some sources of potassium nitrate or calcium nitrate, have nondissolving materials or coatings that should be skimmed off the top of the tank. Another method is to use a flocculating agent that will cause these materials to drop out of solution and settle to the bottom of the tank. Fertilizer dealers/salespersons can assist in choosing the right method.

An alternative to using dry fertilizers is to buy solution fertilizers like 4-0-8 or 7-0-7. These solutions are also available with micronutrients added.

Scheduling the Fertilizer Application

You may use as much fertilizer material with fertigation as with other methods, but you generally get better production because of the increased availability of the nutrients to the plant as a result

Table 1. Solubilities of Some Common Fertilizers Used in Drip Fertigation.

Material	Composition			Salt Index	Solubility
	(%N)	(%P_2O_5)	%K_2O		(lbs. /100 gal. cold water)
Calcium nitrate	15.5	0	0	52	851
Potassium nitrate	13.0	0	44	73	108
Ammonium nitrate	33.5	0	0	100	984
Sodium nitrate	16.0	0	0	100	608
Urea	46.0	0	0	75	651
Diammonium phosphate	16–18	46–48	0	29	358
Nitrate of soda potash	15	0	14		980

Nutrient	Cantaloupe	Cucumber	Eggplant	Pepper	Squash	Tomato	Watermelon
(percent)							
N	2.00–4.00	5.0–6.0	4.0–6.0	5.00–5.50	4.00–6.00	3.50–5.00	2.50–4.50
P	0.25–0.40	0.3–1.0	0.3–1.0	0.35–0.45	0.25–1.00	0.35–0.45	0.25–0.75
K	1.80–4.00	4.0–5.0	3.5–5.0	4.50–6.00	3.00–5.00	3.50–5.00	2.25–3.50
Ca	1.80–7.00	1.2–3.5	1.0–2.5	1.00–1.50	1.00–2.50	1.00–1.50	1.10–1.50
Mg	0.50–1.50	0.3–1.0	0.3–1.0	0.30–0.80	0.30–1.00	0.30–0.80	0.25–0.80
S	0.20–0.60	0.2–0.8	0.2–0.8	0.15–0.40	0.20–0.75	0.20–0.40	0.20–0.75
(ppm)							
B	20–60	25–75	25–75	25–95	25–75	30–100	30–75
Fe	40–200	50–200	50–200	40–200	40–200	45–200	40–200
Mn	20–200	25–200	25–200	20–200	25–200	20–200	25–200
Zn	20–60	20–75	20–75	20–60	20–75	20–60	20–75
Cu	4–25	5–35	5–35	5–35	5–35	5–35	4–15

Table 2. Ranges of Sufficient Nutrients in Leaves of Several Crops.

of nutrients being placed in close proximity to the roots. You may also find equivalent production by using less fertilizer applied through the drip line.

- *Preplant Application:* Using a soil test as a guide, the recommended amounts of phosphorous and micronutrients and 20 to 40 percent of the recommended amounts of nitrogen and potassium—if required—are applied during bed preparation prior to applying the plastic mulch and drip tape. This "starter" fertilizer provides some nutrition to the crop during its early growth.
- *Injection Schedule:* The remaining nitrogen and potassium can be applied throughout the season as needed by the crop. The specific schedule will vary depending on the crop. One way to ensure that a crop is receiving adequate fertilizer is to analyze nutrients weekly in foliar samples. Table 2 presents some general ranges of sufficient nutrients in leaves of muskmelon, cucumber, eggplants, pepper, squash, tomato and watermelon. Frequency of fertilizer injection can range from once a week to daily. The more frequent the application, the less potential for problems caused by application delays related to weather conditions and for injury from build-up of soluble salts.

A general recommendation is to start with small amounts of N and K, and increasing the rates as the season progresses and the crop demand increases. Some general guidelines for fertigation schedules of tomato, pepper, and muskmelon are presented in Tables 3, 4, and 5, respectively.

SAMPLE CALCULATIONS

If you want to apply l pound of nitrogen per acre per day, how would you figure the amount of calcium nitrate (15.5-0-0) or ammonium nitrate (33-0-0) needed to accomplish this?

- Step 1. Divide the 1 lb. requirement for nitrogen by the percent nitrogen in 33-0-0 (1 – .33 = 3) or in 15.5-0-0 (1 – .155 = 6.5). This means that 3 pounds ammonium nitrate or 6.5 lbs calcium nitrate per acre will equal 1 pound of actual nitrogen per acre.

Table 3. Suggested Fertigation Schedule for Tomatoes.

Days after planting	Daily Nitrogen	Daily Potash	Seasonal Nitrogen	Seasonal Potash
		pounds per acre		
Preplant	—	—	50.0	100.0
0–7	.5	1.0	53.5	107.0
8–14	.5	1.0	57.0	114.0
15–21	.5	1.0	61.5	121.0
22–28	.7	1.4	66.4	130.8
29–35	.7	1.4	71.3	140.6
36–42	.7	1.4	76.2	150.4
43–49	.7	1.4	81.1	160.2
50–56	1.0	2.0	88.1	174.2
57–63	1.0	2.0	95.1	188.2
64–70	1.0	2.0	102.1	202.2
71–77	1.1	2.2	109.8	217.6
78-84	1.1	2.2	117.5	233.0
85–91	1.1	2.2	125.2	248.4
92–98	1.0	2.0	132.2	262.4
99–105	1.0	2.0	139.2	276.4
106–112	1.0	2.0	146.2	290.4

■ Step 2. Dissolve the fertilizer materials in water. From the solubility chart, you know you can dissolve 984 lbs. of ammonium nitrate and 851 lbs. of calcium nitrate in 100 gals. of cold water. You have only 3 pounds to dissolve, so it should easily go into solution in a small quantity of water.

SUMMARY

Fertigation is another management tool for growers to use in production of selected vegetable crops. It is an extremely effective and efficient method of applying fertilizers and other chemicals via the drip irrigation system. However, it does require more management and attention to details than other methods of fertilizer application. Success in using this system will depend on a sound fertility program based on soil testing and a drip irrigation system that is designed and operated properly.

Additional information can be found in the K-State Commercial Vegetable Production Guides, "Drip Irrigation for Vegetables" and "Plastic Mulches for Vegetables," and the K-State Research and Extension Leaflet, "Tensionmeter Use in Scheduling Irrigation," L-796.

Table 4. Suggested Fertigation Schedule for Peppers.

Days after planting	Daily Nitrogen	Daily Potash	Seasonal Nitrogen	Seasonal Potash
		pounds per acre		
Preplant	—	—	50.0	100.0
0–7	1.0	1.0	57.0	107.0
8–14	1.0	1.0	64.0	114.0
15–21	1.0	1.0	71.0	121.0
22–28	1.2	2.4	79.4	137.8
29–35	1.2	2.4	87.8	170.0
36–42	1.2	2.4	96.2	202.2
43–49	1.8	3.6	108.8	227.4
50–56	1.8	3.6	121.4	252.6
57–63	2.2	4.4	136.8	283.4
64–70	2.2	4.4	152.2	314.2
71–77	2.2	4.4	167.6	345.0
78–84	2.2	4.4	183.0	375.8
85–91	2.4	4.8	199.8	409.4
92–98	2.4	4.8	216.6	443.0

Table 5. Suggested Fertigation Schedule for Muskmelons.

Days after planting	Daily Nitrogen	Daily Potash	Seasonal Nitrogen	Seasonal Potash
		pounds per acre		
Preplant	—	—	25.0	50.0
0–7	.9	1.5	31.3	60.5
8–14	.9	1.5	37.6	71.0
15–21	.9	1.5	43.9	81.5
22–28	.9	1.5	50.2	92.0
29–35	1.3	2.2	59.3	107.4
36–42	1.3	2.2	68.4	122.8
43–49	1.3	2.2	77.5	138.2
50–56	1.7	2.8	89.4	157.8
57–63	1.7	2.8	101.3	177.4
64–70	1.7	2.8	113.2	197.0
71–77	1.7	2.8	125.1	216.6
78–84	.7	1.4	130.0	226.4
85–91	.7	1.4	134.9	236.2

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