Drip Fumigation with K-Pam HL and Vapam HL

Chuck Duerksen*[1] and Husein Ajwa[2]

[1] Product Development Specialist, Amvac Chemical Corporation
[2] University of California - Davis, Salinas, CA

Chemigation, the injection and delivery of agrochemical through an irrigation system, was originally developed for the injection of fertilizers in 1958 and has since evolved for the injection of herbicides, fungicides, insecticides and nematicide. Chemigation can be a safe and effective application method provided that the system is properly designed and operated and safety precautions are followed.

Due to high water solubility, K-Pam HL and Vapam HL soil fumigants are particularly well suited for application through irrigation systems. Compared to other application methods, Chemigation allows for ease of handling and generally lower expenses. K-Pam HL/Vapam HL can be applied effectively though many different types of irrigation systems, such as: border, flood, basin, sprinklers and drip. While this document will have information on the setup and configuration of all types of chemigation, we will deal primarily with drip fumigation.

Why drip

Drip fumigation places the fumigant in the right place, at the right time, and at a desirable concentration. Plant roots grow in areas that are wetted from irrigation. In drip irrigated fields, roots will generally be close to the wetted zone near each emitter. Since K-Pam HL and Vapam HL are fully soluble in irrigation water, they will also travel to all areas where roots develop.

Fumigation through drip lines represents the most convenient option for pest control. Drip fumigation also allows growers to fumigate a field on a flexible schedule rather than having to work around application rig availability. Applying fumigants through drip lines also reduces the potential for worker exposure because the closed system application does not require workers to be in the field during application.

System Considerations

Emitters along the drip tape should be placed no more than 12 inches apart. The position of the drip tape is an important factor in the effective distribution of K-Pam HL and Vapam HL in the plant bed. Best results are obtained when the tape is positioned on the bed surface under tarp (plastic). Uniformity of application is an important consideration when applying K-Pam HL and Vapam HL through drip irrigation systems. The system should be divided into quadrants sized to provide uniform distribution throughout the field.

Drip Fumigation Guidelines

Soil Preparation

The soil should be prepared and tilled properly. Pre-irrigate to initiate weed seed germination and activation of soil borne pests. The beds should be free of clods and firmly packed. The plastic tarp used over the shaped bed should not have holes or tears.

Current soil preparation and bed listing practices used after methyl bromide fumigation are generally adequate. Any shanks or chisels should be removed when laying the plastic tarp to avoid creating channels in the soil, which can result in poor water and fumigant distribution in the soil bed. For uniform water distribution on steep or hilly grounds, the beds should be directed along the contour lines and the beds should not go uphill more than 4 ft. or downhill more than 8 ft. Poor water distribution will result in poor fumigation.

Amount of Water

To ensure optimal control of pests, fumigation must be done with an appropriate amount of water. Too little water can result in poor fumigant distribution and high volatilization losses. It can also cause fumigant precipitation back into the irrigation pipelines. Too much water can reduce the fumigant concentration and therefore effectiveness or could collapse the beds. Fumigants can move beyond the wetting front. Inline and emulsifiable Pic will travel more easily than Vapam or K-Pam. In loamy soils, an application of 1.75 inches of water will wet more than 20 inches. Inline and emulsifiable Pic can move to 24 inches deep. Although the fumigant will volatilize and may move beyond the wetted zone, the best treatment appears to occur within the wetted area.

Application of fumigants in less than 1.5 inches of water often results in poor fumigant distribution and high volatilization losses, which diminishes the ability to control soil borne pathogens and other pests. In addition, application of fumigants with a small amount of water will result in the precipitation of fumigant in the irrigation pipelines if the concentrations exceed their solubility limits. Drip fumigation with a larger amount of irrigation water will result in better fumigant distribution in soil and will reduce fumigant volatilization losses. This occurs by increasing the amount of fumigant in the water phase and decreasing the total air space available for fumigant diffusion in soil. However, excessive amounts of water should be avoided and fumigant concentration in the main line should not be below 250 ppm or fumigant effectiveness might decline. Also, beds can become unstable and collapse with excessive water application amounts, and bed stability may limit the volume or application rate of water that can be applied. In sandy and loamy sand soils, limited lateral water movement may limit fumigation distribution.

Drip Tape Flow Rate and Spacing

The drip irrigation systems should provide high water distribution uniformity (DU) – over 90% is achievable. This will require the use of a good system design and operation in which the pressure variation in the drip tape throughout the field is less than 3 psi (i.e., from 6 to 9 psi). The system should be free of leaks and clogged emitters, and should be flushed and pressure tested before fumigation. It is imperative to use good quality irrigation components and drip tape. Leaks cause fumigant loss and possible odor and emission problems.

Reconfiguration of drip tape spacing may be necessary for good water coverage across the soil bed. For most beds in sandy loam soils, one drip tape can cover up to 10 inches on each side. Therefore, two drip tapes are recommended for drip fumigation of most beds. The tapes should be spread apart as far as possible to cover the edge of the bed. A third drip tape in the center may be needed if the bed top is wider than 40 inches.

Calculations

- Determine 1) the actual treated area, 2) total volume of water and 3) weight of fumigants to be applied.
- Calculate the time required for application based on the drip tape flow rate.
- Determine the fumigant application rate and concentration in irrigation water.

Table 1. Estimated water amount needed to treat <u>two feet</u> of soil depth using two drip tapes. Application time and water volume is based on a 40-inch average bed width (64 inches center-to-center). One acre-inch of water is 27,154 gallons.

Soil type	Amount of application water Inches (gallons)[a]	Drip tape flow rate (gpm/100ft)	Application time using 2 tapes (hours)	Comments
Fine sand and loamy fine sand	1.6 (27,154)	0.5 – 0.67	5.5 – 4.1	Pre-irrigation with one inch of water is needed
Sandy loam and fine sandy loam	2.0 (33,943)	0.5 – 0.67	6.9 – 5.2	Minimum of 1.5 inches is recommended
Sandy clay loam and loam	2.6 (44,125)	0.2 – 0.45	22.5 – 10.0	Split application may be required
Clay, clay loam, and silty clay loam	3.2 (54,308)	0.2 – 0.45	27.7 – 12.3	Soils not common in strawberry production

[a] One broadcast acre-inch of water is 27,154 gallons. One bed acre-inch of water is 16,971 gallons.

Table 2. Concentration (parts per million) of metam in various volumes of irrigation water.

	K-Pam HL (Gallons)								
	28.0	**28.0**	**32.0**	**36.0**	**40.0**	**44.0**	**48.0**	**52.0**	**60.0**
	Vapam HL (Gallons)								
Gallons	**35.0**	**40.0**	**45.0**	**50.0**	**55.0**	**60.0**	**65.0**	**70.0**	**75.0**
of water	**Metam rate (Pounds of Active Ingredient)**								
per acre	**149**	**170**	**192**	**213**	**234**	**256**	**277**	**298**	**320**
19000	940	1075	1209	1343	1478	1612			
20000	893	1021	1149	1276	1404	1531	1659		
21000	851	972	1094	1215	1337	1458	1580		
22000	812	928	1044	1160	1276	1392	1508	1624	
23000	777	888	999	1110	1221	1332	1443	1554	1665
24000	744	851	957	1063	1170	1276	1382	1489	1595
25000	715	817	919	1021	1123	1225	1327	1429	1531
26000	687	785	883	982	1080	1178	1276	1374	1472
27000	662	756	851	945	1040	1134	1229	1323	1418
28000	638	729	820	912	1003	1094	1185	1276	1367
29000	616	704	792	880	968	1056	1144	1232	1320
30000	596	681	766	851	936	1021	1106	1191	1276
31000	576	659	741	823	906	988	1070	1153	1235
32000	558	638	718	798	877	957	1037	1117	1196
33000	541	619	696	773	851	928	1005	1083	1160
34000	525	601	676	751	826	901	976	1051	1126
35000	510	583	656	729	802	875	948	1021	1094
36000		567	638	709	780	851	922	993	1063
37000		552	621	690	759	828	897	966	1035
38000			604	672	739	806	873	940	1007
39000			589	654	720	785	851	916	982
40000				638	702	766	829	893	957
41000				623	685	747	809	872	934
42000					668	729	790	851	912
43000					653	712	772	831	890
44000						696	754	812	870

Safety Rules and Chemigation Equipment for Drip Fumigation

Safety should be an integral part of the process of applying any fumigant. Skin contact with liquid or mist should be minimized through the use of suitable protective clothing, including long pants, long sleeves, and gloves. Eye contact with liquid or mist should be avoided through the use of chemical safety glasses, goggles or a face shield.

Monitor the application system and the field during application. Use a measuring device to determine the flow rate of fumigant and water used to deliver the fumigant. Fumigants should be injected at low flow rates and accurate calibration of injection equipment is essential to a proper application. The fumigant concentration in the mainline may vary from 250 to 2,000 ppm depending on the soil, fumigant type, and water application rate. Good fumigant mixing with water in the irrigation pipelines is essential. A static mixing device is recommended to be installed after the point of injection to thoroughly mix fumigants with water before being distributed into the irrigation system laterals and drip tape. Many fumigants can damage PVC if left in the pipelines. This does not occur during application of the dilute fumigants, but can occur if the lines are not well flushed at the end of the application and the fumigant settles out and accumulates in low points of the distribution system. For this reason, it is critical to flush the lines at the end of each application. The required flush water amount can be estimated at three times the volume of the mainline and laterals. Excessive flushing should be avoided because it will dilute the fumigants around the drip tape.

Once the basic safety criteria have been met, there are various methods of injecting any fumigant into an irrigation line. The irrigation system should be equipped with an injector pump, which has the flow rate range necessary for proper injection of K-Pam HL and/or Vapam HL. The required flow rate is determined by the acres to be treated, the time it will take to apply the desired amount of water and the rate of K-Pam HL/Vapam HL to be applied per acre.

A wide variety of injection pumps are available including water, electric motor and engine-powered units. Both piston and diaphragm type pumps are commonly used for injection into high-pressure irrigation systems. The injection pump should be accurate and easily adjusted for different injection rates. It should be mechanically rigged with the internal and external components acceptable for corrosive material.

There are backflow prevention equipment requirements to meet federal regulations which include:

• The system must contain a functional check valve, vacuum relief valve and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.

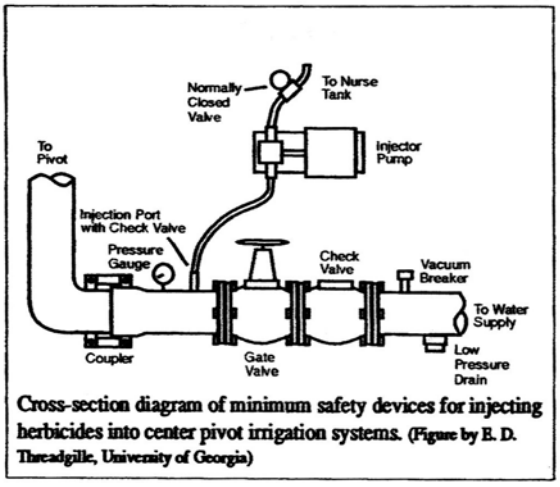
• The pesticide injection pipeline must contain a functional automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.

• The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve, located on the intake side of the injection pump and connected to the system interlock, to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

• The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.

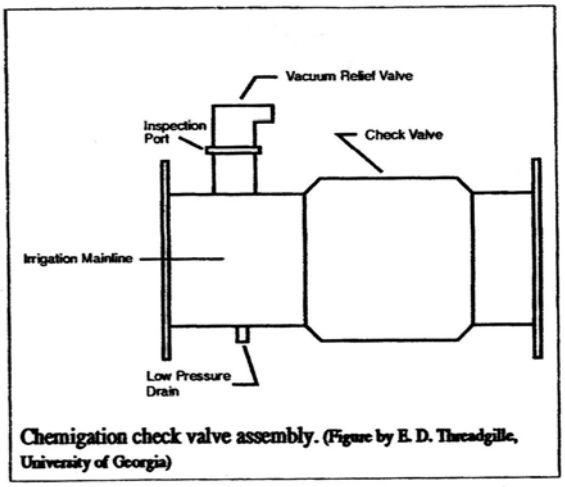
• The irrigation line or water pump must include a functional pressure switch, which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

Represented in Figures 1 & 2 are safety features comprised of two safety systems - a backflow prevention system and an interlocking injection system. The required backflow prevention system consists of a check valve in the irrigation mainline *(Figure 2)* and a vacuum breaker arranged to keep chemical or a mixture of water and chemical from draining or siphoning back into the water source.



Cross-section diagram of minimum safety devices for injecting herbicides into center pivot irrigation systems. (Figure by E. D. Threadgille, University of Georgia)

Figure 1

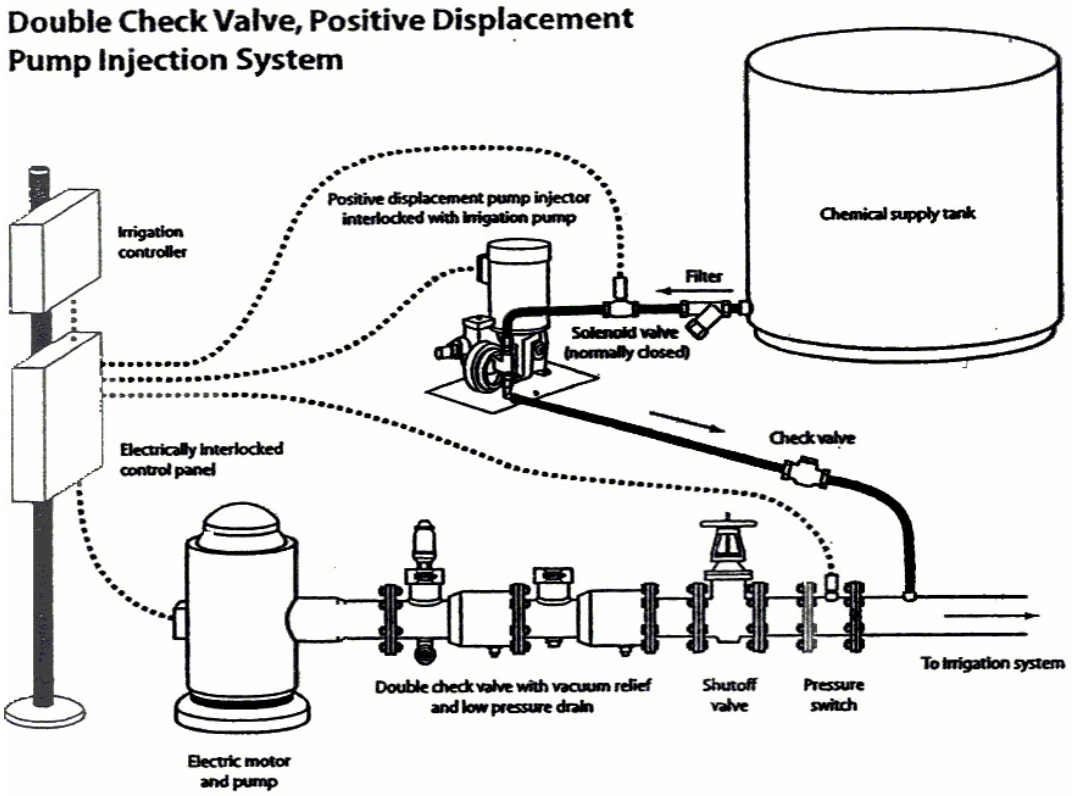


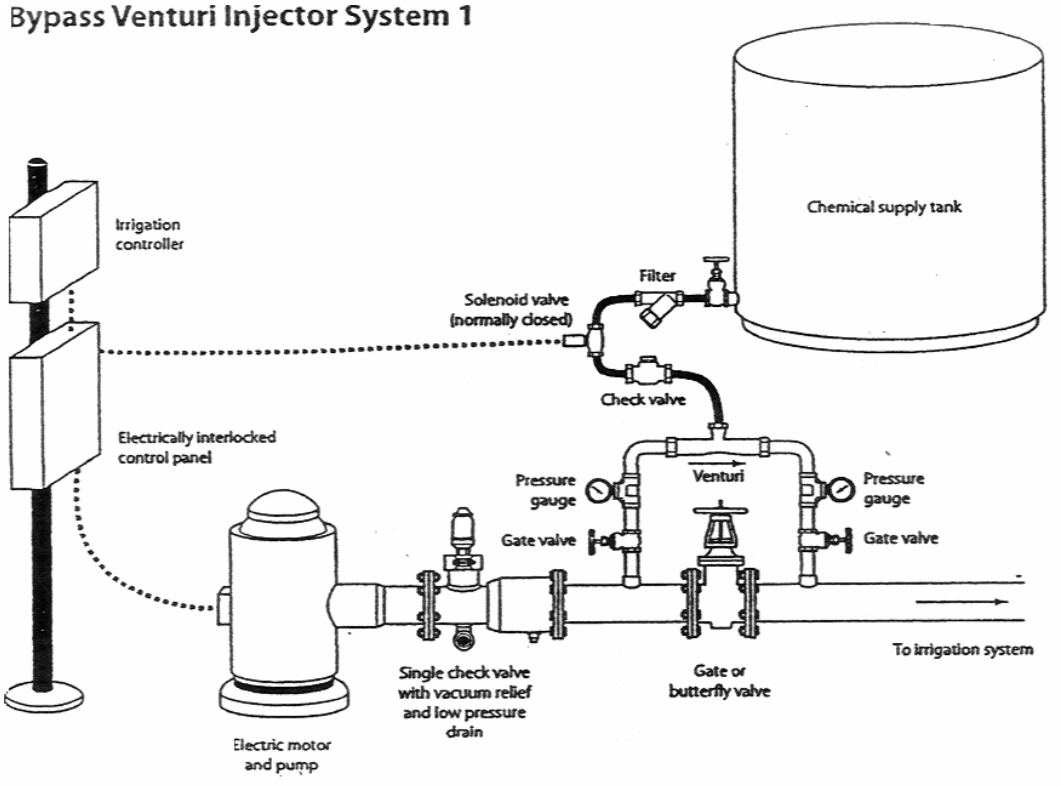
Chemigation check valve assembly. (Figure by E. D. Threadgille, University of Georgia)

Figure 2

Note: Figures 1 and 2 are for general information purposes only and may not depict all safety features required by some states*. Check regulations in your state regarding any additional system requirements.*

These are examples of schematic configurations for injecting K-Pam HL or Vapam HL into an irrigation system. (*The Center for Irrigation Technology, CSU, Fresno)*





Positive Displacement Pump Injection System (alternative device 1)

Spring loaded check valve on intake side of injection pump