INJECTION APPLICATION

When applying TELONE brand products to fields, inject the fumigant into the ground. This is most commonly done with narrow, knife-type shanks (such as forward-swept knives, also called chisels) with metal delivery tubes attached to their trailing edges. Other applicators include bed-forming implements (i.e., ripper hippers) and deep-tillage implements. The choice of implement depends on what is required during preparation of the soil and application of the fumigant.

To ensure a successful fumigation by injection, certain conditions must be satisfied. The soil must be adequately prepared and be of proper temperature and moisture content. Suitable application equipment in good repair must be used and calibrated correctly. Finally, the furrow, or "chisel trace," left by the knife must be immediately sealed to avoid loss of the fumigant to the atmosphere (see product label and Page 25).

APPLICATION GUIDELINES

The fumigant dose (D) necessary to kill a particular pest is a function of the concentration (C) of the toxicant and the time (T) of the exposure ($D = C \times T$).

To achieve a successful fumigation:

1. Use enough chemical to reach a minimum effective concentration throughout the pest area.
2. Maintain the concentration in the pest area for sufficient time to insure an effective dosage of toxicant to the pest.

The chemical concentration necessary to kill specific pests is part of the label recommendation. The way the fumigant works is strongly influenced by soil texture, soil conditions, and soil moisture. Consult the product label to determine the correct amount of chemical to be applied per acre of soil based on the crop to be planted after treatment, the type of treatment (i.e., row or broadcast), and the soil texture.

When selecting the proper rates of TELONE II or TELONE C-17, consult the label and use experience as an additional guide. If experience is lacking, consultation with qualified local authorities is advised.

TELONE II and TELONE C-17 must be placed at the proper depth, as determined by the type of fumigation required. Most crops have the majority of their root systems in the upper 2-3 feet of soil, which requires placement of the fumigant at least 10-12 inches — and for a deeper zone of control, placement at 18 inches or more — below the final soil surface.

Certain nematodes, such as the Columbia root knot nematode, *M. chitwoodi*, require a deeper application depth of 18-22 inches in order to achieve a larger zone of control, as this is a highly motile nematode.

Deeper injection will result in a deeper and larger volume of fumigated soil.

TELONE II and TELONE C-17 may be applied either overall (broadcast) or row.

Overall (broadcast) application. Use either a chisel plow or deep tillage subsoiler with the shanks spaced 12 inches apart. When the fumigant is injected at a depth of greater than 12 inches (deep tillage), the shank spacing may be equal to the application depth, but should not exceed 30 inches.

Application may be made in the same direction or at an angle to the planting row, whichever is most convenient.

If the "V" frame is used to reduce drag, shanks should be spaced horizontally no more than 22 inches apart.

Row application. Use shank equipment with one unit per row, or two shanks spaced 12 inches apart, to treat only the soil where the crop is to be planted. When one shank per row is used, adjust the fumigant flow rate to distribute about two times more fumigant per shank than is recommended for overall (broadcast) application (see label).

When two shanks are used per row, apply at the same flow rate *per* shank as for overall broadcast. In both cases, the amount of fumigant required per acre will decrease as the distance between rows is increased and vice versa.

SOIL CONDITIONS AND PREPARATION

Soil can best be described as a heterogenous mixture of minerals, live and dead plant and animal matter, air, and water. Fumigation is the process of attacking a given pest by introducing a chemical toxicant into air space and/or soil moisture where the pest resides.

TELONE II and TELONE C-17 give the best results when conditions permit rapid diffusion of the gas through the soil. To maximize the effect of fumigation, the soil must be in good seedbed condition, free of clods and undecomposed plant material. This is accomplished by ripping and discing prior to the fumigation.

If undecomposed plant debris is present, it should be plowed down and allowed to decompose before applying the chemical. In soils where a "plow" pan or compact strata occurs in the desired treatment zone, tillage deeper than the plow pan is needed for good fumigant penetration. Soil moisture should be at one-half of field capacity (wilting point) and temperature between 40° and 80°F (4°-26°C) at the depth of injection.

When bed-forming equipment is used, the equipment should be modified to simultaneously inject the fumigant and "list up" (bed) in a single pass through the field. This can also be achieved without bedding or on the flat. *NOTE: The surface must then be sealed immediately (see Page 25).*

EQUIPMENT

Tractors

The tractor must be of sufficient horsepower to pull the chisels through the soil to an adequate depth at the required speed for application.

SOIL SEALING AFTER TREATMENT

To reduce fumigant escape from the soil, adequately seal the soil surface by using a roller or smooth or V-wheel packer to mechanically compact the soil surface; by listing soil over the "chisel trace" (bedding); or by using a polyethylene tarp.

(If an adequate seal is not made soon after application, damage can result to plants growing in immediately adjacent fields, particularly if large amounts of chemical are allowed to drift onto sensitive crops such as lettuce. People and animals may also be unnecessarily exposed to the fumigant if it is not sealed properly.)

Mechanical sealing. Immediately after application, the soil surface should be compacted to prevent fumigant loss. Immediately after application, use a V-wheel packer or similar sealing device to prevent the gas from escaping and drifting into nearby areas, thus exposing nontargets.

Sealing after row application can be accomplished by the tractor wheel or by listing (bedding) so that the fumigant will be 12-14 inches below the top of the bed.

When fumigating already listed beds, seal in the fumigant with ring rollers, press sealers, or by relisting.

Tarping. Relatively vapor-impervious tarps have been used to confine fumigants to the soil.

Usually 1-2 mil polyethylene tarping is adequate to contain the fumigant. In some situations, such as pineapple production in Hawaii and vegetable production in Florida, a layer of plastic (clear or black) is laid down after the fumigant has been applied. This is done to reduce weeds, retain soil moisture and heat from the sun, and confine the chemical to enhance its nematicidal and fungicidal activity. The tarp may be removed after treatment or planting may be done through the tarp.

PRODUCT AND CONTAINER DISPOSAL

Follow all directions on the product labels.

EXPOSURE PERIOD/ AERATION/ RE-ENTRY TIME

After application and sealing, leave the soil undisturbed for 7 to 14 days. A longer exposure period will be required if the soil becomes excessively cold or wet during the exposure period.

At the end of the exposure period, allow the soil to aerate completely before planting the crop. Under optimum soil and weather conditions, allow one week of aeration for each 10 gallons of fumigant applied per acre.

TESTS FOR THE PRESENCE OF THE CHEMICAL

Monitoring. Suitable detection devices can be used to determine if plant-damaging (phytotoxic) levels of TELONE brand products remain in the soil at the time of planting. One such device is the infrared detector MIRAN 101, manufactured by Foxboro Wilkes. (For other information on detection equipment, contact a Dow sales office. Addresses are listed inside the back cover.)

The active ingredient in TELONE II is 1,3- dichloropropene. In TELONE C-17, 1,3-D is one of two active ingredients. The 1,3-D vapors are easily collected on charcoal tubes, which then can be analyzed in a laboratory.

Odor. Aeration is usually complete when the odor of TELONE II and TELONE C-17 is no longer evident in the treated soil, particularly in the shank area. *Do not plant if there is an odor of the fumigant in the soil.*

Seed test (lettuce). Certain seed, such as lettuce, is extremely sensitive to fumigant vapors and can be used as an indicator of the presence of the chemical.

Soil from the treated area can be placed in small sealed bottles, planted to lettuce seed, and watered. In less than a week, the seed should be growing well, and it should be green and thrifty. Presence of 1,3-D will cause yellowing, browning and stunting of the seedings. In the case of high concentrations, the seed may be killed.

Collect soil samples from a depth of 6-18 inches, using a sampling tube if possible, and random sample treated areas and composite samples into about 5 treated and 5 checks (untreated).

Deep-rooted crops. When TELONE II or TELONE C-17 are used for treating deep-rooted tree and shrub planting sites, an aeration period of 3-6 months may be required. To hasten aeration, especially if heavy rains or low temperatures occur during the exposure period, work the soil with clean (uncontaminated) equipment to the depth of the treatment zone.

Row treatment. Use a narrow shank (knife) in the bed without turning the soil, thus reducing possible contamination of the treated soil.

Overall treatment. To hasten aeration, plow or deep cultivate to the depth of the treatment zone. This is especially desirable in northern climates after fall fumigation of muck soils.

PLANTING THE CROP

Use uncontaminated seeds, seed pieces, or propagation plant parts so as not to infest a field that has just received fumigation treatment. Follow planting guides recommended by local university extension personnel or farm advisors.

PLANTING OFFSET FROM TREATMENT LINE

At the time of planting after row application of fumigant, avoid placing the seed row directly over the furrow left by the applicator shank. When a single shank is used per row, place the seed 3-4 inches to one side of the shank furrow. When two shanks are used, plant in the center of the area between the shank furrows. A plow down or ripper hipper (bedder) is preferred in some areas.

PLANTING IN THE ROW

If planting into unbedded rows, place seed at the depth required for proper germination.

When beds are "freshened" (crusted top scraped off), seeds are planted at appropriate depth to allow good germination.

NOTE: If row treatment is used (not broadcast or total area treated), care must be taken not to contaminate the treated area with infected soil such as when mechanically cultivating for weed control.

RESULTS OF A SUCCESSFUL FUMIGATION

Because of the soil complexity, it is difficult to determine just how a nematicide has produced a positive impact on a crop. It may be that the fumigant has controlled certain pathogenic fungi by killing them outright or it may have stimulated predacious fungi, which then can increase and hold the pathogenic organisms in check.

If plant parasitic nematodes are inhibiting the growth of plants, the fumigant may act directly by reducing their population to non-detectable levels, allowing the crop to produce to its maximum.

If TELONE brand products are applied properly under conditions described on the label, the fumigation should be a success. Improvement of crop production or quality due to fumigation will depend on the severity of the nematode/disease problem and the vigor of the crop planted — which depends in part on good cultural practices and climate.

Where nematodes or soil-borne diseases have not been present at sufficient levels to have an impact on yield, only modest yield increases can occur from a fumigation. In severe cases, however, enormous increases have occurred after treatment, ranging from 50-1500%.

CONSEQUENCES OF AN IMPROPER FUMIGATION

If the amount of chemical applied was insufficient, the nematode population will, in all probability, be equal to or greater than before the treatments due to lack of sufficient control and subsequent population growth. If too high a rate was used, phytotoxicity may occur, unless an adequate aeration period is provided. (See — Phytotoxicity.)

INADEQUATE NEMATODE CONTROL

In order to do its job properly, the chemical must reach the pest it is to control. The placement of the chemical is vitally important. For pests found several feet in the soil, the chemical must be placed (injected) deep into the soil. If the crop is shallow rooted, the conventional application at 10-12 inches deep may do the job properly. However, the ability of the pests (organisms) to migrate both vertically and horizontally should determine the depth of control needed.

Nonmigratory pests may allow shallower control to be effective.

Soil moisture, which can limit diffusion, and temperature, which can slow diffusion, are also important.

The fumigant must have continuous soil air space to reach the nematodes or other organisms.

PHYTOTOXICITY

When phytotoxicity occurs, the seed may never emerge; if plants do grow, they may tend to be off-color (yellow to brownish) and probably stunted in growth. The plants may exhibit symptoms that resemble fertilizer burn or nutritional imbalance.

Phytotoxicity most commonly is caused when TELONE brand products are applied when the soil is cold and/or wet, with insufficient time for aeration — a condition that will not allow the chemical to diffuse adequately through the soil. An excessive dose near the point of injection can also suppress the biological degradation of TELONE brand products.

Certain growing stages of crops are much less tolerant of 1,3-D than others. Dormant seeds are more tolerant than young, tender seedling transplants. A longer waiting period may be required after treatment to allow the chemical to perform its function of killing target soil organisms and then degrade or dissipate sufficiently to pose no problem to the crop that will be planted.

RECONTAMINATION OF TREATED SOIL

TELONE brand products normally provide no residual control of soil pests. However, an excellent fumigation may allow two or more years' suppression of a disease, without always effectively controlling the casual organism. This is but one example of the complexity of interrelationships among various factors responsible for disease suppression.

Reinvasion can come from contaminated irrigation water, propagation parts (seeds, seed pieces, transplants), equipment, human foot gear, animals, plant hosts, and wind.

IRRIGATION WATER

Nematode larvae, eggs, and some adults are readily moved by irrigation water and rain runoff, and may be transported over long distances through irrigation systems.

SEED/SEED PIECES/ TRANSPLANTS

Planting nematode-infested seed, seed pieces, or plants can contaminate new land or land recently treated with a nematicide, where below-ground plant parts are used in propagation. However, pest introduction during the first growing season is not likely to have an economic effect on yield and quality the same year, unless the crop is to be used for transplanting (annuals, perennials) or the pest is one that can reproduce rapidly (i.e., Columbia root knot nematode).

EQUIPMENT/FOOT GEAR/ANIMALS

Nematodes can be transported in soil particles and in plant debris carried on farm workers' shoes and the feet of animals and birds. However, the movement of farm equipment probably is most often responsible for nematode introductions.

Eggs within the cysts of the sugarbeet nematode have been shown to survive passage through the digestive tracts of cattle. Because of this, cattle grazing in an infested field can spread some species of nematodes.

WEED AND GRASS HOSTS

Many weeds and grasses are alternate hosts for numerous plant nematodes and diseases. It is advisable that an adequate herbicide program be conducted or a routine discing be done to eliminate weeds in the treated area and on the margins of the field.

WIND

Even wind can contribute to the long-distance spread of nematodes. In a study in Texas, the eggs of 28 genera, including 14 plant-parasitic species, were caught in wind traps in a single week. In this study, only live larvae were counted. Counts ran as high as 20 larvae per gram of soil.