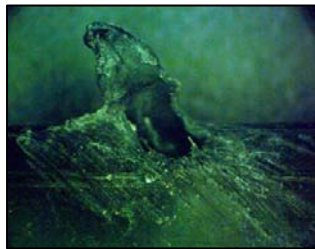


# Diagnosing and Avoiding Damage to Drip Tape

Prepared for the IA by the  
IRRIGATION TRAINING AND  
RESEARCH CENTER, CAL POLY, SLO  
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Drip/Micro CIG of The Irrigation Association

## PURPOSE OF THIS PUBLICATION

The evolution of drip tape materials, drip tape emitter pathways, and hardware to connect, install, and remove/retrieve drip tape has been nothing short of phenomenal since the early drip tape days of the 1970's. Drip tape has been successfully used on millions of acres of cropland, often with exceptional savings in water and improvements in crop quality and yields.

A major advantage of using tape materials, as compared to harder wall hose and emitters, is a low price per foot. But this tremendous advantage brings with it a higher sensitivity to physical damage. Precautions must also be taken to minimize problems with plugging the relatively small flow passageways of the emitters. This is not to say that problems will unavoidably occur with drip tape – but problems have occurred and they are often misunderstood or misdiagnosed.

This publication is meant to help farmers, dealers, and manufacturers recognize and understand some of the problems that have been experienced with drip tape – problems that are quite different from manufacturing defects. Problems that are quickly detected and properly identified can often be remedied, or be avoided in the future.

This publication is organized by the category of problems that have been encountered. The primary categories are:

- Installation and retrieval
- High pressure
- Emitter plugging
- Insects, gophers, and other pests
- “Magnifying glass” or “lens” effects

*For further information:* Manufacturers can often provide excellent brochures related to irrigation system maintenance. The book *Drip and Micro Irrigation* sold through the Irrigation Association (IA) contains detailed information regarding maintenance, filtration, and other important issues related to drip irrigation that are beyond the scope of this publication. Note that this publication only provides assistance for identifying problems. The correct diagnosis and solution of problems requires that an irrigation expert see and examine the problem in the field.

### **Disclaimer**

Reference to any specific process, product or service by manufacturer, trade name, trademark or otherwise does not necessarily imply endorsement or recommendation of use by either California Polytechnic State University, the Irrigation Training and Research Center, The Irrigation Association, or any other party mentioned in this document. No party makes any warranty, express or implied and assumes no legal liability or responsibility for the accuracy or completeness of any apparatus, product, process or data described herein. Photos and materials for the preparation of this publication were primarily provided by the Cal Poly ITRC and John Deere Water. Toro Micro-Irrigation, Jain, and Netafim also contributed.

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## IMPORTANT GUIDELINES FOR DRIP TAPE USERS

1. Drip tape is one component of a complete irrigation system. A complete irrigation system should have been designed by a competent designer and installed by a competent installer who included:
  - a. Proper filtration.
  - b. A means to frequently and adequately flush water from the ends of tapes.
  - c. Sufficient injection points for chemicals that are required to maintain the cleanliness of the tape and emitters. These chemicals may include acids, chlorine, and various polymers.
  - d. Fertilizer injection points upstream of the filters.
  - e. Fertilizer injection equipment.
  - f. Pressure regulation to limit excessive pressures in the tape, plus to minimize emitter pressure differences throughout the field.
  - g. A water meter that, in addition to keeping a record of water applied, can be useful in detecting leaks or clogged lines.
2. The grower and persons who are responsible for irrigation must understand the fundamentals of:
  - a. Proper adjustment of filter backflush.
  - b. Chemical injection for minimization of emitter plugging.
  - c. Proper fertilizer injection, including how various chemicals can be checked in advance for reaction between each other and with the water.
  - d. Tape flushing.
  - e. Installation, retrieval, and field repair of tape.
3. Pest control (insect, rodent, etc.) is required at all times for drip tape systems. Before installing a tape system, consult a Pest Control Advisor (PCA) regarding pest problems noted in this publication, plus other locally known pests. The pest problem must be solved before installing the tape.
4. Take care to protect drip tape from indiscriminate damage during handling, storage, etc.
5. After installation, immediately pressurize the system and check for leaks and proper pressures.
6. Always cover tape with soil to prevent sun damage from plastic covering, to minimize expansion/contraction due to temperature changes, and to prevent the wind from moving the tape.
7. Only use well-designed and maintained installation and retrieval equipment that is free from burrs and rough edges where tape can come in contact with the equipment.
8. Avoid excessive pulling on the tape, which can cause tape stretching or breakage.
9. Install the tape so that the holes are pointed up; this helps minimize plugging.
10. Properly prepare the soil before installing the tape. Soil clods that sit on top of the tape can prevent water from traveling past that point. It may take days to soften the clods enough so that the tape can expand and allow water to flow into the rest of the tape length.

11. The flow rate printed on the tape roll is the average flow if all emitters are at the pressure that is stated on the new roll label (e.g., 0.22 GPM/100' at 8 psi). There are always pressure differences throughout a field, and there is usually a pressure drop along the manifolds and tape downstream of a block pressure regulator. Therefore, if a pressure regulator is adjusted to the pressure on the new tape roll, the average emitter pressure is less than the pressure regulator setting, and the average emitter flow is typically less than the “rated” or “nominal” flow rate.

## ***Recognizing Problems***

### **Non-uniform wetting patterns**

Non-uniform wetting patterns at the soil surface are often not related to manufacturing defects. Tape emitter flow rates may be very uniform, yet the wetted pattern on the top of the soil throughout a field may appear very erratic. This is especially noticeable with subsurface drip irrigation (SDI) – where the tape is buried 8” or more below the ground surface. Causes can include:

- Varying soil textures throughout a field (e.g., sand vs. loam vs. clay).
- Varying installation depths of the tape.
- Varying soil compaction.
- Different soil chemistry conditions.

### **Water exiting from holes other than emitters**

This problem is easy to spot, but it can be difficult to identify the exact cause. Observe the damaged tape under a magnifier to assist in identifying typical causes. Possible causes include:

- Insect damage. This publication contains photos and a discussion of this common problem.
- Rodent damage. Gophers and similar rodents can cause extensive damage with SDI.
- Rabbits and birds. These problems can appear on surface-laid tape.
- Mechanical damage due to handling (storage, transportation, installation, or retrieval).
- Mechanical damage while in the field, such as by workers, tractors, etc.
- Sunburn of tape under plastic mulch (“lens” or “magnifying glass” effect).
- Bursting of the tape due to high pressure.
- Manufacturing defects.

### **Non-uniform flows from emitters themselves**

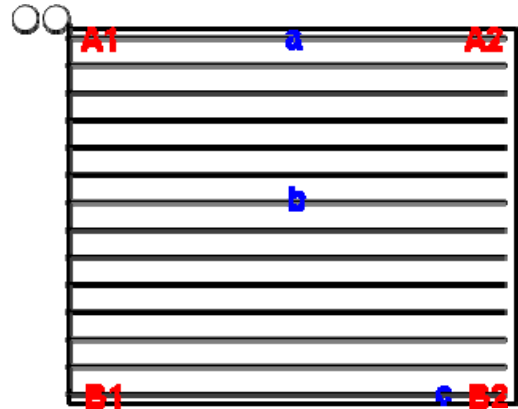
There is no shortcut to knowing if the emitter flow rates are uniform. A sufficient number of accurate emitter flow measurements must be made, and this means that tape must be dug up. Two types of measurements are needed; the basics of taking these measurements are described below. If a person wants to use the measurements to calculate the “Distribution Uniformity” (DU) of water within a field, there is a specific procedure to use that is not explained here. Cal Poly ITRC provides an annual short course to train people on the procedures to determine DU on drip/micro systems. ITRC

also has a software package to assist people in performing a Rapid Field Evaluation ([www.itrc.org](http://www.itrc.org)), but that should only be used after taking the short course.

## ***Measuring DU on Drip Systems***

The two types of measurements needed are:

1. *Pressure measurements.* Pressure measurements must be made throughout the field, because the question is if there are pressure differences between emitters. All pressure measurements must be taken in the tape itself – not in PVC, oval hose, or lay-flat hose. Locations for pressure measurements are:
  - A. At the first hose in each manifold
    - A1. Beginning of the tape lateral (upstream end)
    - A2. End of the tape lateral (downstream end(s))
  - B. At the last hose in each manifold
    - B1. Beginning of the tape lateral (upstream end)
    - B2. End of the tape lateral (downstream end(s))
2. *Emitter flow rate measurements.* The objective is to determine whether there are differences in flow between emitters that all have the same pressure. Therefore, it is common to take emitter flow rate measurements at a minimum of three locations throughout a field. At each of the three locations, at least 16 individual emitter flows should be measured and recorded. The measurement locations can be described as:
  - a. In the middle of a tape lateral (halfway between the tape inlet and the downstream end) near the filter.
  - b. In the middle of a tape lateral in the middle of the field.
  - c. At the end-of-the-end. That is, the end of the last tape lateral on the last manifold. This is usually where plugging problems show up first.



## **Equipment needed for measurements**

1. For pressure measurement, the general guidelines are:
  - Use a quality pressure gauge that is well-maintained. Those with an oil-filled case tend to have protection against pressure shock. A good pressure gauge typically costs at least \$50.
  - Use a pressure gauge with the proper range. A 100 psi gauge is completely inadequate for measuring 8 psi, for example. The proper range for 8 psi tape would probably be 0-15 psi. However, some tape is over-pressurized, and if a 15 psi gauge is used on an 18 psi spot, the gauge can be damaged. Therefore, it is recommended that one start with a 0-30 psi gauge. Once the pressures are known, if more precision is needed one can use 0-15 psi gauges where the pressures are known to be low.
  - Install a pitot tube on the end of the pressure gauge.

- Punch a hole in the tape, and then insert the end of the pitot tube into the tape – making sure that there is a snug fit and there is minimal leakage. Lay the gauge on the ground, facing up, and read the pressure.
- Repair the tape with a goof plug or coupling after removing the pitot tube.



**Figure 1. 30 psi oil-filled pressure gauge with pitot tube stuck into tape**

2. For emitter flow measurement, the general guidelines are:

- First, place a loose piece of hose segment on each side of each emitter hole, to ensure that the water from each hole will not run down the tape.



**Figure 2. Radiator hose segments placed on tape for flow measurement, one on each side of the emitter. Note the square cornered container that is easy to pour into a graduate cylinder without spilling.**

- Use 16 or more square-cornered plastic containers, with one placed under each emitter.



**Figure 3. Plastic containers lined up in preparation for flow measurement of individual emitters. Notice the pressure gauge in the foreground.**



- Collect water from each emitter for exactly the same amount of time. For drip tape, the minimum collection time is usually about 5 minutes. It is easiest to have 2 people available, so the tape can be lifted and placed over all the containers simultaneously.
- Measure and record the water collected in each individual container, using an appropriately sized graduated cylinder. The appropriate graduated cylinder size for medium and low flow rate is 100 ml. The appropriate size for the high flow rate is 250 ml. Typical volumes of water one might collect in 5 minutes are:

“low flow tape”	40 milliliters (ml)
“medium flow” tape	60 ml
“high flow” tape	80 ml

Graduated cylinders can be purchased online from a variety of companies. The flow rate per 100’ of tape can be computed as:

$$\frac{\text{GPM}}{100'} = \frac{\text{Avg. emitter milliliters}}{\text{Minutes of collection time}} \times 0.132 \times (\text{emitter spacing, inches})$$

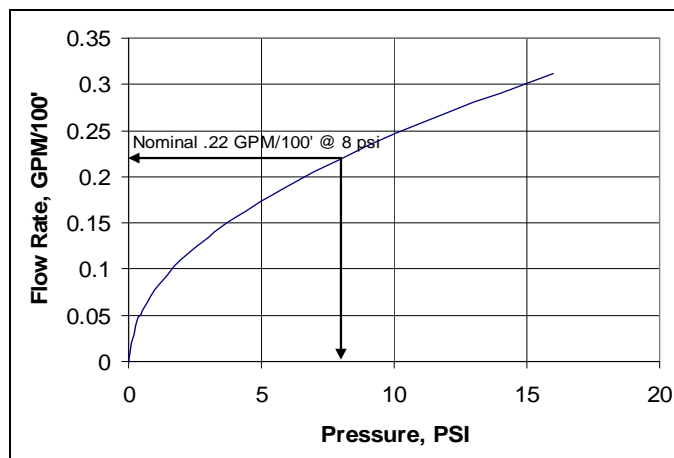
Cut apart any emitters that appear to have unusually high or low flows. Carefully inspect the insides for blockage and wear, and try to identify any substances.

### *Interpreting the Results*

1. *Pressure differences.* Large pressure differences do not necessarily mean there are large flow rate differences. Some tapes have pressure compensating (“PC”) features so that if the pressures vary but lie within a specified range, the emitter flows are supposed to be about the same. Most tapes have non-PC emitters that give 41% more flow if the pressure is doubled. That is,

If the flow rate is 8 ml/minute at 7 psi, the flow rate will be about  
11 ml/minute at 14 psi.

Once you know the pressures, consult with an irrigation expert to determine how the flows of the specific tape product you have should respond to pressure differences.



**Figure 4. Example drip tape performance graph**

Possible causes of pressure differences include:

- Improperly adjusted automatic pressure regulators
- Insufficient number of automatic pressure regulators
- Malfunctioning pressure regulators
- Pipe/hose/tubing with small diameters
- Tape lengths too long for the diameter of tape, flow, and slope
- Partial blockage of a pipe or tape

2. *Flow rate differences between adjacent emitters – with all emitters in a group having the same pressure.* The causes of emitter flow differences can be numerous. The observations of cut-apart emitter pathways are important in making the determination.

Possible causes of flow differences include:

- Root intrusions – especially in SDI
- Precipitation of chemicals, such as:
  - Calcium carbonate
  - Fertilizers
  - Gypsum
  - Iron
- Bacterial growth, including
  - Slimy bacteria
  - Sulfur bacteria
  - Manganese bacteria
  - Iron bacteria
- Dirt that has flowed through the filter, or that was in the pipes since installation.
- Manufacturing variation. In general, this is relatively minor (less than +/- 5% or so) with good tape products.

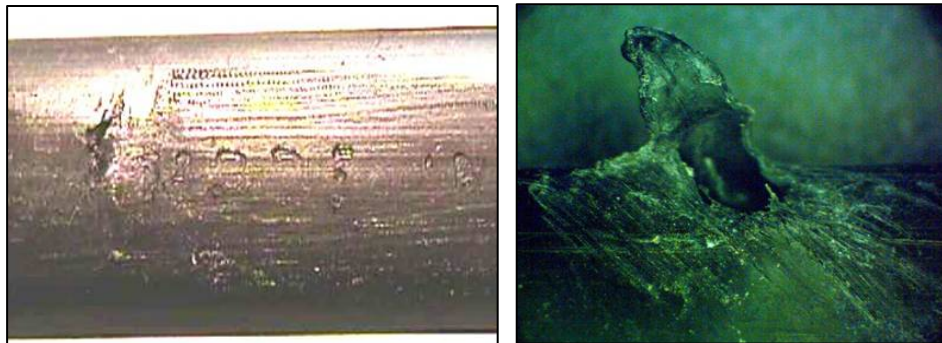
This publication contains a variety of figures that illustrate some of the plugging possibilities. A chemical analysis of the plugging material may be necessary in some cases to determine the source.

## INSTALLATION AND RETRIEVAL DAMAGE

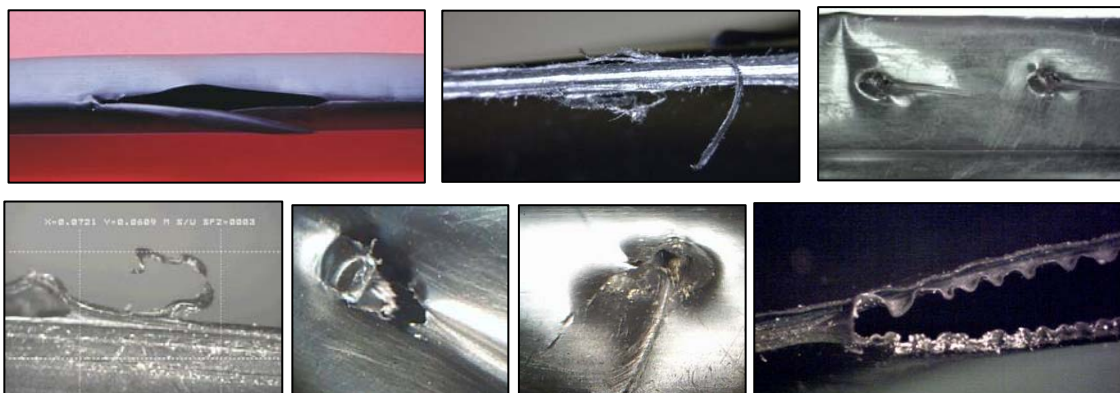
The most common installation damage is caused by burrs and rough edges on installation equipment, or by foreign objects lodged in the installation equipment. The result is generally a systematic, repeatable, directional pattern of damage. The scratches or damage will be on the outside edges of the tape. Common symptoms are curls coming off the drip tape, and slices or small cuts along the edges of the tape.

Extreme care must be taken to purchase high quality injection equipment. Things to check for include:

- Hand pull tape through each piece of injection equipment. Rub the drip tape on the inside of the tool while pulling. Then closely examine the tape for damage.
- Examine the injection equipment for metal or sharp points on the equipment that come in contact with the tape.
- Look for dirt, rocks, or foreign objects that are jammed into the drop tube and injector shoe.
- Check the roller guides to make sure that the tape is positioned to not come in contact with any metal edges.
- Look for consistent patterns of damage, such as one out of every 4 rows.



**Figure 5. Equipment damage**



**Figure 6. Installation damage to tape**



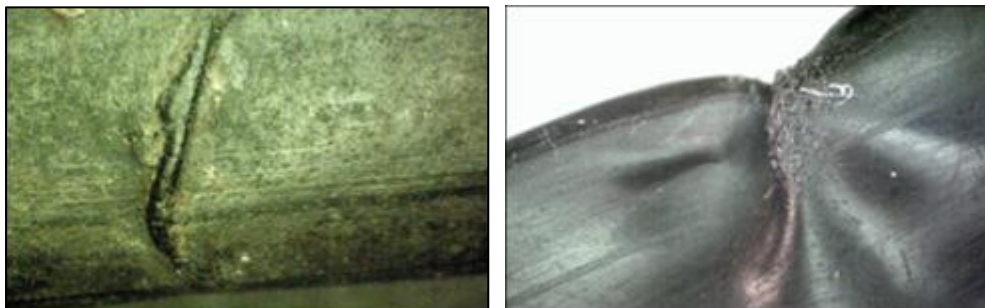
**Figure 7. Leaks from mechanical damage. This tape had been retrieved and installed on 16 different produce crops before the photo was taken.**

“Friction burn” damage is caused by the tape rubbing, or being trapped, against the cardboard sides of the roll during installation. Sometimes the cardboard roll itself breaks apart and it spins at a different speed than the tape roll.

A well-designed tension break is very important. If the tension is too great, the tape will stretch. If it is too loose, or occasionally changes tension, the tape roll can spin or “freewheel”, which will often trap the tape against the sides of the cardboard roll. Friction burn damage manifests itself as a razor cut or a shredded edge, and will often occur for awhile, disappear, and then reappear many hundreds of feet away.

Retrieval damage in the form of tape stretching is common if the tape length is too long, the air temperature is too hot, the tape has not been lifted above the crop to facilitate end retrieval, and/or if the tape has not been adequately drained before retrieval. Thicker wall tapes help to minimize the problem of stretching.

Other mechanical damage can occur due to tractors driving over tape, people walking on the tape and pushing the tape onto clods or rocky ground, weeding crews hitting the tape with sharp implements, and in numerous ways during the transport and storage of new and used tape.



**Figure 8. Symptoms of “other” mechanical damage**

# PLUGGED EMITTERS

## *Root Intrusion*

Quite often, root intrusion into emitters cannot be detected unless the emitter pathways are cut apart. The roots may be so fragile that they break off when the tape is unearthed.

Two common causes of root intrusion are:

1. Under-irrigation.
2. Partially plugged emitters due to other causes (e.g., dirt), which in turn causes under-irrigation near the emitters.



Figure 9. Examples of root intrusion

## *Plugging Problems not Caused by Roots*

Considerable work has been done over the past 30 years to minimize plugging problems. However, plugging contaminants generally arise from three different conditions:

1. Material that moves with the water and plugs the emitters by itself, such as:
  - a. Sand or algae that is moving past filters. Filters should remove all sand and algae.
  - b. Material that was never flushed out during installation.
  - c. Material introduced with dirty chemical injection equipment.
  - d. Dirt that is introduced during a line break.
  - e. Chemical precipitates. This is very common, and can be caused by fertilizers interacting with one another, or by fertilizers interacting with the irrigation water. Calcium carbonate precipitation is also a problem.
2. Bacterial growth within the emitters. This may be simple slimy bacteria or bacteria associated with a mineral in the water (e.g., iron, manganese, or sulfur). Slimy bacteria are problematic because silts and clays (which are rarely removed by drip filters) will attach to the slime and increase the blockage.
3. Dirt that is sucked backwards into the emitter outlet if a vacuum occurs in the tape when the system or block is shut off. This problem is typically characterized by

dirt particles lodged in the emitter pathway near the outlet. Interestingly, the blockage usually occurs three or more zig-zags inside the emitter path from the outlet.



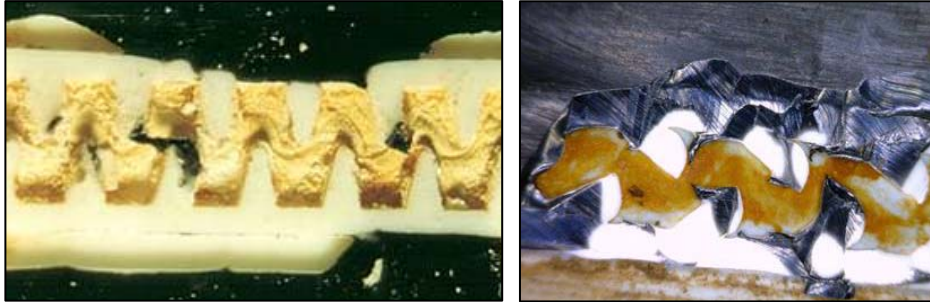
**Figure 10. Extreme cases of bacterial slime plus silt and clay (l) and iron deposits (r) plugging an emitter**



**Figure 11. Plugged inlets to the emitter path**



**Figure 12. Dirty flush water. This is an indication of impending plugging problems**



**Figure 13. Extreme cases of chemical plugging**



**Figure 14. Chemical precipitate flushed from tape. The unidentified chemical compound was supposed to be a fertilizer. It was injected downstream of the filters and plugged a complete irrigation system.**

This brochure is intended to raise awareness of problems that can be caused by chemical interactions and poor filtration. To adequately discuss those topics in detail would require another 30-50 pages. Readers are referred to more detailed texts that are available on the subject of Fertigation and Drip/Micro design and filtration.

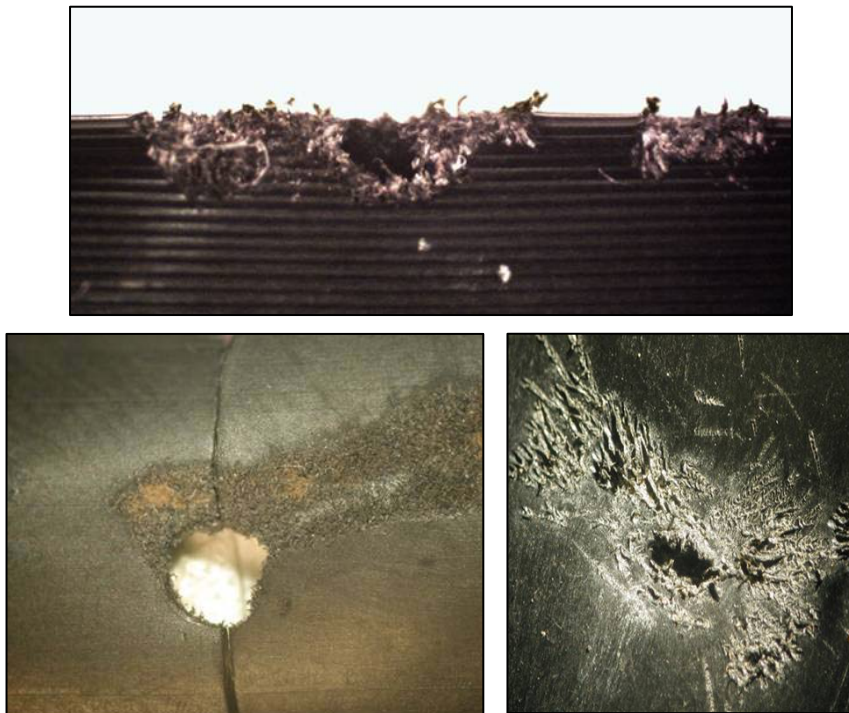
# CRITTER DAMAGE

## *Insects*

Guidelines include:

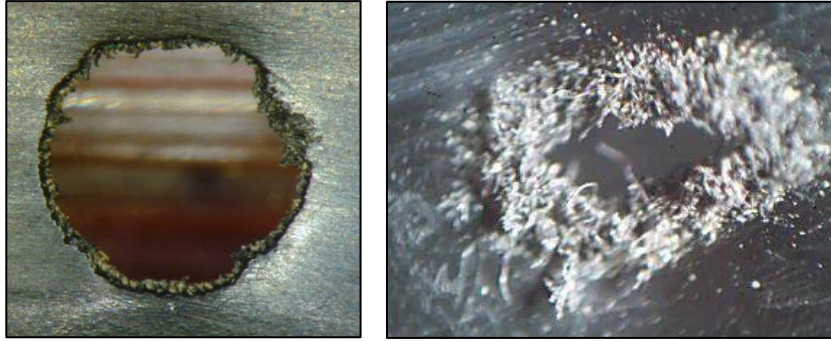
1. A qualified Pest Control Advisor should be enlisted to recommend the proper pesticide to use prior to installing the tape, where the pesticide should be applied, and the proper dosage.
2. Thicker tape is more capable of withstanding insect damage than thinner-walled tape. In some areas, 8 mil wall thickness has been sufficient to minimize insect damage. In other areas, 15 mil tape has been needed. There is no universal rule.
3. There are still many unknowns about insect damage, but the following practices have appeared to help minimize insect damage:
  - a. Pressurize the tape immediately after installation, to wet the soil
  - b. Practice crop rotation

The photos below illustrate insect problems that have been encountered. A qualified entomologist could identify the types of insects in the field.

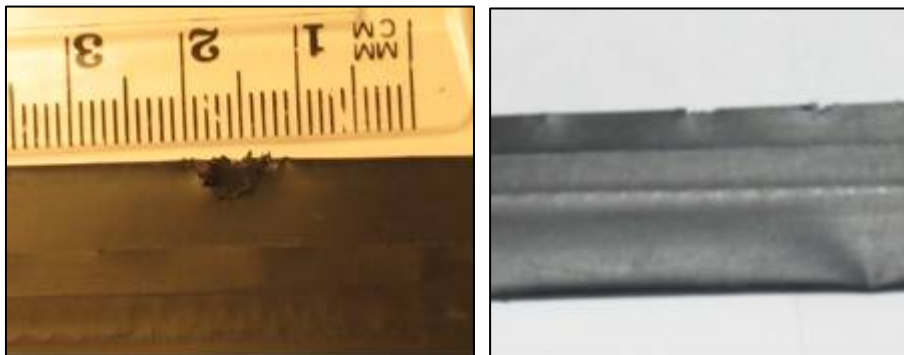


**Figure 15. Examples of insect damage**





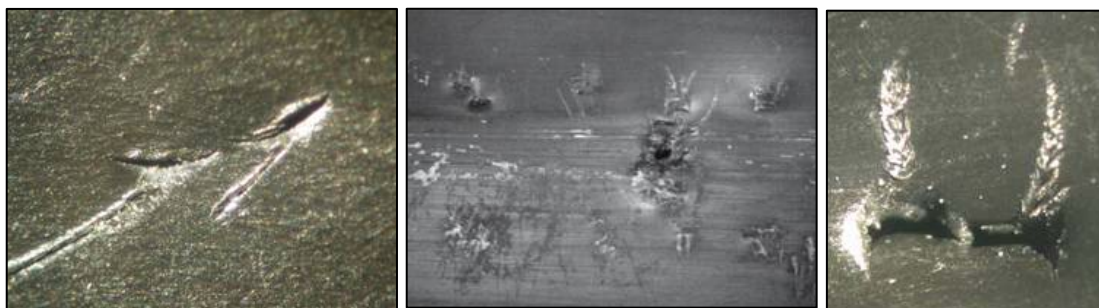
**Figure 16. Typical wireworm damage. An almost perfectly round hole is made in the tape. Frayed edges are also common with insect damage.**



**Figure 17. Cricket damage often (but not always) shows up on the sharp edges of tape because the insects can grab the edges by their mouths. But boring insects (such as wireworms) will damage any part of the tape.**

## ***Rodents***

Sometimes rodents leave scratch marks on tape and hose. The photos shown have been taken using a high-powered microscope that aids in determining the actual cause of the damage. In viewing the damaged tape it can be ascertained how the hole, tear or fraying has taken place. Typically with insect or small rodent damage the ripping, tearing, or biting by the insect/rodent is clearly evident when the microscope photos are examined.



**Figure 18. Examples of rodent damage, generally with characteristic scratch marks**

## **Gophers**

Gopher damage is not subtle. Gophers chew big holes in buried tape and hose. It can be troublesome to locate the damage because water will sometimes travel horizontally for some distance before rising to the ground surface. The author does not know of any easy cure for gophers.

If the downstream ends of the tapes are connected to a flushing manifold, the water will gush out of the hole from two directions. This helps minimize dirt from washing into the tape sections downstream of the cut.



**Figure 19. Surface water from gopher strikes on SDI tape**

## ***Birds***

Bird damage is relatively rare on tape, but it is more common on harder drip hose. In general, one can identify birds as the culprits because shreds of tape are poked inward.



**Figure 20. Bird damage on 15 mil tape. The hole is typically somewhat concave inward**

## OTHER CAUSES OF DAMAGE

### *“Magnifying Glass” or “Lens Effect” Damage*

If transparent (clear) plastic mulch is used on top of beds, water droplets on the under side of the plastic can act as magnifying glasses – concentrating the sun’s rays on small areas of exposed drip tape and burning holes in the tape wall.

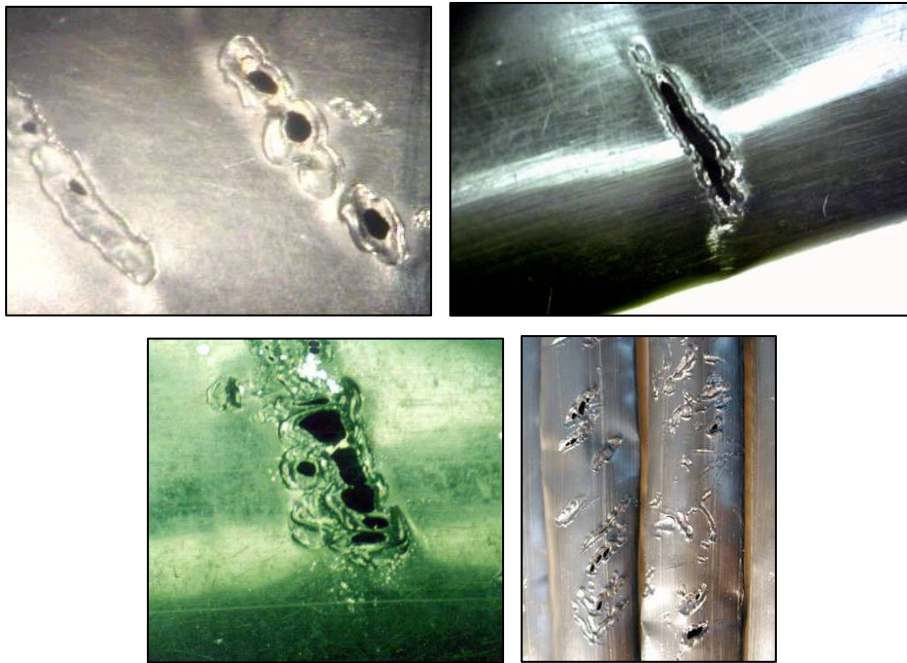


Figure 21. Damage due to the “magnifying glass effect”. Note the rounded edges.

### *High Pressure*

High pressures will cause the tape to balloon out and burst.

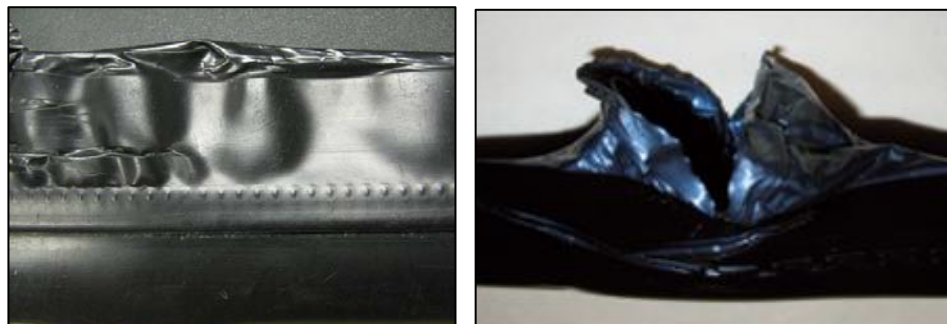


Figure 22. Tape damage due to excessive pressure