Diagnosing Herbicide Induced-Injury

Clyde L. Elmore, Extension Weed Specialist
Weed Science Program, University of California, Davis

Diagnosing a tree or vine problem can be fun and/or frustrating. It is difficult to see all situations or be familiar with them and know all possible combinations of things that can happen, thus trying to formulate a plan to obtain all the information available to solve a problem is difficult but rewarding. It can also help the grower, so the problem will not happen again and reduce the need for costly and unpleasant court proceedings. I would like to propose a thinking process to get to the right solution, rather than show all the possibilities.

If there is a need to confirm a diagnosis, especially in court action cases, it is required that there be a chemical analysis of the cause, whether it is herbicide, other pesticide, nutrient excess or deficiency or combinations of these. Laboratory analyses are expensive however, and it is necessary to be close to the right answer, or know the answer, then confirm with the analysis. An additional section could be prepared on what and where sampling is to be taken to show the results necessary. Suffice it to say that if the sample isn't taken and processed (stored, transported and submitted) properly, the results are worthless. It is critical to know if leaves, shoots or roots are needed and where, when and how much sample is to be taken. After the sample results are obtained, one needs to be certain that the quantity found would be able to "cause" the symptom.

It should be remembered that not all symptoms found on plants are caused by herbicides. There are many other causes of disruptions in plant functions that will cause symptoms, some of which may look like herbicides because the same plant functions (photosynthesis, respiration, amino acid synthesis, etc.) will be affected.

What are some of the necessary prerequisites for solving a problem?

- Keep an open mind!
- Ask questions!
- Use tools (shovel, magnifying glass, auger)
- Observe patterns!
- Look at all the plants present!
- Know the "normal" plant!
- Know how different herbicides work in plants!

It is necessary to gather as much information as possible. If one doesn't have all the information, it is easy to make the wrong diagnosis. Often it is desirable to "eliminate possibilities" as it is to go to the right answer. In fact, it is part of the method of reaching the correct answer. Some of the information needed is, conditions before the symptoms developed [temperature, wind (speed and direction), rainfall or irrigation]. The same information is needed at the time of any application of pesticide. The same is true for the time right after the application of a pesticide. One needs to know the location of the problem and characteristics of the site

including the soil type (sand, silt, clay) organic matter and pH. It is also helpful to know the conditions of the planting as to whether it is a vigorous orchard or is it currently under stress from some factor(nutrients, water, frost).

At the location there are certain factors that one can look for.

These include:

- Obvious symptoms,
- Patterns (edge, roads, drainage, even distribution by row or by varieties)
- Outside influences or associations with other surroundings such as other fields nearby, railroads, roads, ditches)

Often there are patterns of symptoms in an orchard or vineyard. If there is a single source, this will become apparent as you move from one side of the orchard to the other. If the symptoms are uniform over the total area, then it is likely that a misapplication was made or a pattern from a weather front or inversion occurred.

When looking for patterns there are several possibilities. These include:

- Is it a single plant? Or sporadic plants?
- Is it over the whole orchard? Or single rows, or an edge?
- Is it on a single species or variety?
- Does it occur on a single part or side of the plant?
- Is it associated with a single species of weed?
- Is it related to topography?

Within the site are the symptoms associated with a certain part of the plant such as leaves, or stems(shoots or canes)? If it is found on the leaves, do the symptoms show as

- Marginal chlorosis?
- Spotted chlorosis?
- Veinal or interveinal chlorosis?
- Overall leaf yellowing?
- Marginal necrosis (burning)?
- Spotting necrosis?
- Whole leaf necrosis?
- Petiole or new leaves twisting?
- Stunting-without color change (if anything, they may be greener)

Though it would not be common, symptoms could show on the limbs or canes without showing much effect on the leaves. It is also feasible that you were not able to see the foliar symptom when leaves were on the vine. In limbs or canes do the symptoms appear as:

- Tip dieback?
- Limb dieback?
- Flagging of the stem (a dead area on one side of the stem that causes the stem to turn at an angle)?
- Stems swelling at the nodes?
- Stem cracking?
- Advantageous growth?

Then finally, where are the symptoms in the tree or vine:

- Tops of the canopy?
- A side of the tree (which side?).
- New growth/new leaves
- Old growth/old leaves
- Roots (newly planted trees and vines)

All of these factors can be placed on a form that can be carried into the orchard at the time of evaluation. It can even be used as a check-off list, or to help remember all the components to find the required information. This is not planned to be a complete list and other information should be added as needed.

Often diagnosing a problem is not a simple, straight-forward practice. There should be a logical method of determining an answer but there are always quirks. Some of these would include:

- Species of plants react differently to a herbicide.
- Environmental differences cause response differences.
- Plant growth stages will give different symptoms.
- Plant stress alters plant response.
- Combinations of herbicides may give different symptoms, or some of both materials but doesn't look like either alone.

On perennial crops the symptom on the crop often will be different depending when the contact of the herbicide occurs and the how the herbicide works. Symptoms of contact herbicides will look different on new leaves compared to old leaves. They can even look differently if the leaves are dry when the contact is made compared to wet leaves or if a rain or irrigation occurs shortly after the contact. A translocated herbicides will also show a different symptom if the contact is on new leaves or buds compared to old leaves or woody bark contact. Herbicide symptoms from different herbicides will take a different amount of time from contact to symptom at different times of the year. This difference can be either altered by temperature (high temperature equals faster) and how fast the plant is growing. If the plant is stressed at the time of

contact the symptom will be slower in appearing. It may make the symptom more severe if the material is a contact herbicide, but if the herbicide is translocated it often will be less severe.

As an example we could use glyphosate as the herbicide and determine what symptom might occur at different times of application and when and what symptom might occur.

If the application was in the late summer or fall, there might not be any symptom observed until next spring as the plant starts budding. New foliage would show symptoms of feathering (decreased internode length and many new buds pushing). If rates were high in the summer, there could be killing (necrosis) of the mesophyll cells of the leaf giving an appearance of parts of the leaf dying. If the plant was continuing to grow, then new leaves would be affected after the application. If the application was applied in the spring on new growth of the plant, then the new leaves could be chlorotic early with necrotic leaves and stems later. If the rates increase then the stems could be killed with new emerging growth that was not contacted appearing almost normal, or the new growth would eventually be normal, with no lasting effect. The amount of leaf or stem damage would be proportional to the rate.

Another method of analysis could soon be worthwhile as a positive test for an herbicide. This method is with an immunoassay. Currently, several herbicides including 2,4-D, atrazine, simazine, alachlor, metolachlor, triclopyr, imazapyr, chlorsulfuron, metribuzin, metsulfuron-methyl, molinate and paraquat can be found at different levels in water using this method. Though they may not work with tissue currently, it may be feasible to make them work in this manner.

In summary, there are several major factors to keep in mind when working on a diagnosis. First, keep an open mind. Don’t overlook the obvious. Consult or seek advise from others but don’t let someone lead you to a decision which you are not comfortable that it is right answer.