SUPPLEMENT TO: APPLY PESTICIDES PROPERLY

This supplement is intended to give additional information on three major sections of the manual developed by the EPA in cooperation with the Extension Service, USDA, for certification of pesticide applicators. The three sections include the following: 1) weeds and their recognition, 2) how herbicides work and 3) how herbicides harm the environment. Any plant can be a weed when it is growing where it is not wanted. Our objective is to control the unwanted plants.

WEEDS AND THEIR RECOGNITION

1. Life cycle
   A. Annual — complete life cycle from seed in less than 1 year
      Summer — sprout in spring, die in fall
      Winter — sprout in fall and winter, die in spring or summer
      Most of our annuals are summer annuals. Also, those classified as annuals in temperate areas may not be annuals in Hawaii because of insufficient cold to kill off the weeds in the fall.
      Examples: goosegrass, spiny amaranth
   B. Biennials — requires greater than 1 year, but less than 2 years to complete life cycle. These sprout in spring and only produce leaves the first summer; the next summer, they will mature and produce seed. This type is not very important in Hawaii because they need the cold period of the first winter to induce the flowering stalk the next spring or summer.
   C. Perennials — live more than 2 years and may live indefinitely. These may germinate from seed, but usually from vegetative materials such as tubers, rhizomes, stolons, etc. Therefore, a lot of stored foods are associated with the germinating seedling, and the seedling is generally harder to control.
      Examples: purple nutsedge, Johnsongrass from rhizomes.

2. Morphology — weeds classified in these groups often behave similarly to herbicides.
   A. Grasses — narrow leaves, flat or round stems, parallel veins
      Example: goosegrass
   B. Sedges — narrow leaves, three-angled stems, parallel veins
      Example: purple nutsedge (nutgrass)
   C. Broadleaves — broad leaves, netted veins
      Example: spiny amaranth

Weeds are often listed on the herbicide labels under the following categories: 1) annual grasses, 2) annual broadleaf weeds, and 3) perennials. Since many of the weeds listed on labels are not found in Hawaii, a few of those listed or common in Hawaii are listed below:

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
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<tbody>
<tr>
<td>goosegrass (wiregrass)</td>
<td><em>Eleusine indica</em></td>
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<tr>
<td>foxtails</td>
<td><em>Setaria spp</em></td>
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<tr>
<td>sandbur</td>
<td><em>Cenchrus echinatus</em></td>
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<tr>
<td>barnyardgrass</td>
<td><em>Echinochloa crusgalli</em></td>
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<tr>
<td>jungle ricegrass</td>
<td><em>Echinochloa colonum</em></td>
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<tr>
<td>spiny amaranth</td>
<td><em>Amaranthus spinosus</em></td>
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<tr>
<td>purslane</td>
<td><em>Portulaca oleracea</em></td>
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<tr>
<td>spurges — garden</td>
<td><em>Euphorbia hirta</em></td>
</tr>
<tr>
<td>gracefull prostrate</td>
<td><em>Euphorbia glomerifera</em></td>
</tr>
<tr>
<td>popolo, black nightshade</td>
<td><em>Euphorbia prostrata</em></td>
</tr>
<tr>
<td>purple nutsedge</td>
<td><em>Cyperus rotundus</em></td>
</tr>
<tr>
<td>paragrass, californiagrass</td>
<td><em>Brachiaria mutica</em></td>
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<tr>
<td>dallisgrass</td>
<td><em>Paspalum dilitatum</em></td>
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<tr>
<td>guineagrass</td>
<td><em>Panicum maximum</em></td>
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<tr>
<td>torpedograss</td>
<td><em>Panicum repens</em></td>
</tr>
<tr>
<td>bermudagrass</td>
<td><em>Cynodon dactylon</em></td>
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</tbody>
</table>
1. Why are weeds a problem?
   A. Reduce yields
   B. Reduce quality of produce
   C. Increase management costs
   D. Harbor insects and diseases, thus affecting disease and insect control (Emilia/Flora’s paintbrush) — host tomato spotted wilt virus
   E. Others

2. Why do weeds persist?
   A. Dormancy — a mechanism by which seeds or other plant organs do not germinate. This can occur even if environmental conditions are favorable for germination, thus we cannot usually allow all weeds to sprout, kill them and have no weed problem thereafter.
   B. Longevity — length of time where seed is alive and able to germinate.
   C. Dissemination — many weeds have special mechanisms which allow seeds to spread.
      Examples: barbs on Spanish needle, sandbur; fluffy attachment to seeds of Flora’s paintbrush, crabgrass.
      Other weeds like nutsedge very rarely germinate from seed, and the main method of dissemination is by movement with cultivators and other machinery, or by simply growing laterally.


**HOW HERBICIDES WORK**

1. Spectrum of control
   A. Selective — control or kill only certain weeds and have little or no effect on other weeds and desirable plants if used properly. Weed species may vary from one locale to another, and therefore control of weeds may vary.
      Example: Dalchale controls most annual grasses but is generally weak on broadleaves. It can be used safely in many vegetable crops when used according to label; 2, 4-D control broadleaves at low rates, without affecting grasses.
   B. Non-selective — kills most plants.
      Example: Paraquat, Karmex at high rates (at lower rates, it can be used selectively).

2. Movement in plants
   A. Contacts — usually kill only the portion of the weed that the herbicides contact; mostly non-selective.
      Example: Paraquat; therefore, these herbicides should not be contacted with foliage of desirable woody plants or with any portion of a desirable herbaceous plant.
   B. Translocated herbicides — translocated in plants following either foliage or root absorption.
      Examples: 2, 4-D, Roundup—when applied to the leaves, it moves to growing buds and root system.
      Examples: Aatrex, Karmex—when applied to soil, they are absorbed by root system and translocated to leaves.

3. When to use
   A. Preemergence — any treatment made before the emergence of a crop or a weed.
      Examples: Vegadex, Dacthal
   B. Preplant — treatment made before the crop is planted, usually because the herbicide needs to be incorporated into the soil.
      Example: Eptam
   C. Postemergence — treatment made after the emergence of a crop or a weed.
      Examples: Dalapon, Roundup, 2,4-D
      Often, it may be necessary to modify the definitions. For example, an herbicide may be suggested for use after the crop is up, but before weeds have germinated. In this case, its usage would be defined as postemergence to the crop and pre-emergence to the weed.

4. How to use
   A. Band — application to a strip or bank over a crop row.
   B. Broadcast — uniform application to an entire area.
   C. Directed — aiming herbicide at a portion of a plant, usually its base.
**HOW HERBICIDES WORK — ADDENDUM — (For Commercial Applicators)**

1. **Spectrum of control**
   
   A. Each herbicide will control only certain species of weeds at a given rate. The rate can be modified by environmental and soil differences. However, the relative susceptibility usually remains the same.

   B. Species within families usually behave similarly and one can generally draw a generalization between species in a family behaving similarly to an herbicide. However, even within a family, certain weed species will also vary in response to an herbicide.

   C. Shifts in weed population can often occur with repeated use of an herbicide.

2. **Movement in plants**
   
   A. Translocated herbicides — often, a translocated herbicide like 2,4-D can become a contact herbicide at excessive doses since high rates kill the translocation system in plants, and thus prevents, 2,4-D movement. This will naturally result in poorer control of perennial weeds.

3. **Factors affecting herbicide activity**
   
   A. Soil factors — organic matter and clay tend to reduce the activity of an herbicide, thus, soil containing a higher amount of organic matter and clay require a higher rate of herbicide. The label will provide a rate range. The higher rates are appropriate with a higher organic matter content. Also, an herbicide has a greater tendency to leach deeper in the soil zone with sandy soils. Warmer temperatures may cause some herbicides to volatilize faster (Examples: Treflan, Eptam) from the soil surface, and thus herbicidal activity is reduced. Moist soils at the time of application generally increases the initial activity of a soil-applied herbicide and better control is often attained. Also, some crop injury may result if soils are wet. Furthermore, volatile herbicides as Treflan or Eptam are lost from moist soils faster than with dry soils if they are not incorporated immediately.

   B. Climatic factors — rainfall may affect herbicidal activity. Rainfall soon after postemergence applications can reduce the effectiveness of the herbicide. However, some rain or irrigation is necessary to “activate” preplant or preemergence herbicides. Without moisture, these herbicides do not work well. Excessive rain or irrigation can also cause some soluble and poorly adsorbed herbicides to leach down through soil, thus providing poor weed control and often injury to the crop. Warm temperatures and high humidity often increases herbicidal action because of better absorption of the herbicides into plants, and plants tend to grow faster under these conditions.

**HOW HERBICIDES HARM THE ENVIRONMENT**

1. **Direct kill of non-target organism**
   
   A. Drift — movement of spray particles by wind away from the target area. This is an important consideration in Hawaii because of our fairly strong tradewinds. These herbicide spray particles can drift to nearby crops or landscape plants, causing injury or killing them. Certain herbicides pose a more serious problem, such as 2,4-D or other hormone-type herbicides, which can cause injury to many broadleaf plants at very low doses. Drift can be reduced by:

   a. Not applying when strong winds persist.

   b. Spraying at low pressures (increase particle size).
c. Using a nozzle with the largest possible orifice opening (increases particle size).
d. Use a thickener in your spray mix (increase particle size; sometimes the use of a thickener may not give good coverage).

B. Volatility — refers to the “evaporation” of an herbicide from its original, liquid state. Many herbicides will kill plants in the vapor state, and because of the ease of gas movement, will often kill plants in non-target areas. The danger is greater with higher temperatures and higher wind velocities. The most important herbicide here is 2,4-D. Some ester formulations are more volatile than the amine formulation.

C. Leaching and surface run-off can be a problem with excessive rainfall or irrigation, and in sloped areas. The most severe problems may occur with soil-sterilant materials such as Hyvar, or with hormone-type herbicides, as 2,4-D, Banvel, or Tordon.

HOW HERBICIDES HARM THE ENVIRONMENT — ADDENDUM — (For Commercial Applicators)

1. Direct kill of non-target organisms
   A. Volatility — (HV esters (short chain) > LV esters (long chain) > Amine) (H₂O soluble)

   Cheaper than LV ester
   Best penetration

   An oil-soluble amine is also available. The advantage is better penetration into leaves with low volatility, but it is usually more expensive.

B. Leaching of hormone-type herbicides into soil zone — many hormone-type herbicides used in turf can cause damage to ornamentals in and around the turf area. This problem is generally more severe in sandy soils, or areas irrigated heavily. Generally speaking, hormone-type herbicides used in turf should not be applied within the drip-line area of ornamental plants.

NOTE: Persistence of Herbicides
Most soil-applied herbicides are generally active between 1 and 6 months, at which time they no longer control weeds, but still may be present in the soil. However, as persistence is usually dependent on the rate of breakdown by microorganisms in the soil, any action favoring microorganism growth would favor herbicide breakdown. Sufficient soil moisture, warm temperatures, and an energy source (sugar) for microorganisms in the soil will all aid in more rapid breakdown. For example, the amount of Karmex in a soil may be reduced by one-half in 60 days under optimum conditions, but may not be degraded at all in dry areas without much rainfall or irrigation.