# Weed Management, Herbicides and Soil pH

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Good weed management has to be one of the most challenging aspects of a cranberry grower's task. There are only a few registered herbicides, it is doubtful more will ever be registered, the rates required for weed control either damage the cranberries or are not legal, it is not possible to till, and the overall soil/water environment is not user friendly for herbicides. Therefore, a grower has to fine tune and understand the system from both anherbicide and non-herbicide approach in order to succeed. This paper addresses those concerns in three points: 1) the interaction of the soil environment (microbiology, chemistry and moisture) with herbicides, 2) the interaction between weed biology and soil pH and, 3) the fine tuning of herbicide application timings, rates and combinations.

**1) Herbicide and soil environment interactions.**

*Microbiology:* Unfortunately, weed control varies tremendously among sites and across years. Several years ago we began to notice a loss of efficacy in weed control after the second year of Devrinol use (Figure 1). By the third and fourth years, we were getting no weed control. This loss of weed control effectiveness with each successive use has been reported in the literature for Devrinol (Walker and Welch, 1992) and is termed, enhanced microbial breakdown. Basically, this means that the population of microbes that breakdown the herbicide increase with continued use. Therefore, the half-life in the soil continually decreases. The best solution to avoid this problem is to stop using an herbicide for several years. We are now trying to determine if other herbicides have this the same characteristic. Literature indicates that it happens with 2,4-D and our preliminary data suggest that it happens with Casoron.

*Soil chemistry;* Herbicide behavior in soil tends to follow the fundamental laws of physical chemistry. All herbicides have a binding affinity to organic carbon. The higher the binding affinity, the greater the propensity to be tied up in the soil matrix.

For example, we generated standard curves for Casoron in different soils commonly used for cranberry growing. Figure 2 shows that relationship on a logarithmic scale. It takes 2 ppm of Casoron to achieve 50% kill in sand and over 30 ppm of Casoron on peat. That is, weed control on peat requires ten-fold more Casoron than on sand. A knowledge of the organic matter content in your cranberry bed is vital for obtaining a balance between weed control and phytotoxicity. On soils with little organic matter, the herbicide half-life is also greatly diminished. Casoron may last for several years on a peat soil and only months on a sand soil. Based on these principles, we have found that multiple applications of Casoron on sandier soils are frequently better than a single application.

*Soil Moisture*. Without good drainage in a cranberry bed, herbicide response becomes unpredictable. Most growers are familiar with Evital puddling in the low spots. Other problems include soil moisture effects on herbicide persistence. Casoron persistence is shorter under unsaturated soil conditions (25 - 50% moisture) than saturated conditions (75 - 100% moisture) (Figure 3). This factor helps explain the higher frequency of Casoron damage on cranberry beds where drainage is poor.

**2) Manipulation of the weed biology through altered soil pH.**

***Soil pH and weed biology:*** Soil pH greatly affects the composition of plant species occupying a given ecosystem. Many weed species occur within a limited soil pH range. A differential response to changes in soil pH between cranberry and a specific troublesome weed could result in a competitive advantage for the cranberry. Surveys in Massachusetts found that cranberry bogs with the greatest production and fewest weeds had the lowest soil pH. Soil acidification, therefore, may be a viable weed management practice in a cranberry planting for several weed species. For example, in leguminous weed species such as clover which are sensitive to soil acidity, modification in soil pH can be used to help provide control.

We have been conducting research on the use of sulfur for soil acidification of established cranberry bogs to determine efficacy of weed control and phytotoxicity, and the interaction of soil pH and herbicides.

The legume weed, Birdsfoot Trefoil is particularly difficult for West Coast growers to control. Figure 1 shows the change in Trefoil coverage with the change in soil acidification over several years. In the first year of treatment, Trefoil was not observed below a soil pH of 4.0; by the second year of treatment it was not observed below pH values of 4.5. That means that a lower pH is needed for quick control. Gradual control is accomplished at a slightly higher pH. In the same vein, control of some species by using soil acidification may actually take years. For example, it took three years to eliminated Potentilla with sulfur. Weed control by acidification appears to occur as the result of mineral imbalances and, therefore, takes time to express.

The acidification of most cranberry soils with sulfur is not permanent. The sand layers on which the cranberries grow were poorly buffered. Use of high pH water, for example, will cause the soil pH to drift back to its initial levels within a year. In cases of severe weed infestation, all weed control benefits will be lost unless additional sulfur is applied (see Figure 1). The amount of supplemental sulfur required for pH maintenance is usually less than what is needed for the initial pH reduction. This is usually because populations of autotrophic sulfur oxidizers are stimulated by sulfur applications. The need for maintenance doses should be determined by running soil pH values once or twice a year.

We learned the hard way that sulfur applied at too high a rate in a single application can be quite phytotoxic. Rates below 500 lbs./ac/application were usually safe; rates above 1000 were not. Therefore, several applications at 100 to 200 lbs/ac applied 4 to 6 weeks apart were usually most satisfactory. The texture of the material was also a significant factor in phytotoxicity. Coarse material that took a long time to break down was safer at higher rates. Sulfur applied in an emulsifiable concentrate was very fast acting but caused some phytotoxicity if rates were too high.

The biggest problem we had with soil acidification was the occurrence of phytotoxicity on beds that were poorly drained and had long durations (more than 1 week) of standing water after sulfur applications. Well-drained sandy sites with no standing water after applications were free of noticeable phytotoxicity on cranberries. That is, peaty soils were always problematic and sandy soil much less so. The cause of toxicity was not directly related to soil acidification but to the reduction of inorganic sulfur compounds. Under conditions of poor drainage, sulfate is reduced to sulfite and then to sulfide. Free hydrogen sulfide is toxic to roots and will accumulate under waterlogged conditions. Apparently there is sufficient sulfite or sulfate under these wet conditions to allow for toxic levels of sulfide production. Successful use of sulfur on cranberry bogs, therefore, seems limited to well-drained plantings, application timings which avoid periods of water logging, and gradual rather than rapid acidification. In conclusion, although soil acidification has its limits, well drained cranberry beds with a soil pH above 5 and where poor herbicide efficacy has resulted in an over abundance of legumes and other weeds, should be considered for sulfur applications as part of the weed management program.

*Herbicide and soil pH interactions:* In general, we found that, when soil acidification was combined with herbicides, much lower rates of herbicides could be used to achieve control of several weed species. There could be several reasons for this. First, some herbicides like Devrinol are reported to work better at a low pH than moderate or high pH (Johnson and Bums, 1985). Second, the suppression of weeds by Devrinol wears off early, at which time the more gradual influences of soil acidity can come into effect. Third, soil acidity may weaken the weeds making them more susceptible to herbicide damage. This latter factor may be especially important for perennial weeds.

**3) Fine tuning of herbicide use.**

Since we have so few herbicide options it is important that we maximize their effectiveness by the proper choice of application timing and rates, and by the best use of herbicide combinations. These recommendations are site specific so only general principles will be mentioned here. Most obvious is to use the right herbicide for the right weed. Table 1 with the matrix on which herbicide controls which weed can be used to provide that information. Herbicides last longer on peat beds but higher rates are required for weed control. On sand beds, low rates will provide control but the time frame for control is shorter. Split applications of Casoron should be considered in this case. We have had consistently better weed control with less phytotoxicity when Casoron has been applied in two or more small applications, spaced 3 to 5 weeks apart, compared to a single large dose. The second dose can be lower than the first and should be applied before bud development is very advanced. The new 1996 label revision allows for this type of modification in Casoron use. Herbicide combinations have also been successful for control of several of the more difficult weeds in Washington. This includes Casoron with Devrinol in a 1: 1 or 1: 1.25 ratio, or Casoron with 2,4D-G in a 5: 1 ratio put out in split applications. For the worst weeds, a typical application might be a Casoron:2,4D mix at 60# total product/acre in early March followed by 40 to 50# of this mix in early April. This example is not a recommendation for Wisconsin and is used only to illustrated that numerous combinations and multiple applications can be used to improve weed control. On-farm research is suggested to optimize those rates, timings, and combinations.

**Literature Cited**

Johnson, B. J. and R. E. Bums. 1985. Effect of soil pH, fertility, and herbicides on weed control and quality of bermudagrass *(Cynodon dactylon)* turf. Weed Science 33:366-370.

Walker, A. and S. J. Welch. 1992. Further studies of the enhanced biodegradation of some soil-applied herbicides. Weed Research 32: 19-27.

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Loss of Devrinol Effectiveness for Trefoil Control With Continued Used

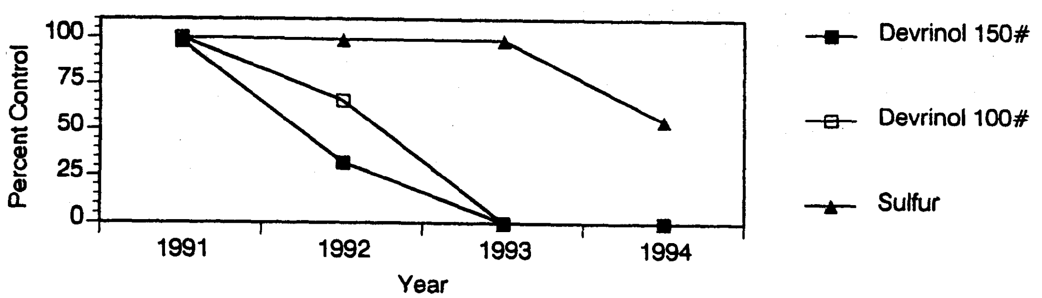


Figure 1 -- The loss of effectiveness of Devrinol and sulfur for Trefoil control with continued use. Devrinol 10 G @ 150# product/ac was applied in February and the 100#/ac rate was applied in March. Sulfur rates were 500 #/ac in 1991 three times, 500#/ac in 1992 once, 250#/ac in 1993 once and 100#/ac in 1994 once. This data demonstrates the likelihood that enhanced microbial degradation of Devrinol in cranberry beds is occurring. The data on sulfur also demonstrates how weed control can be lost when soil pH can drift upward over time as a function of not reapplying sulfur in adequate amounts to maintain a low pH.

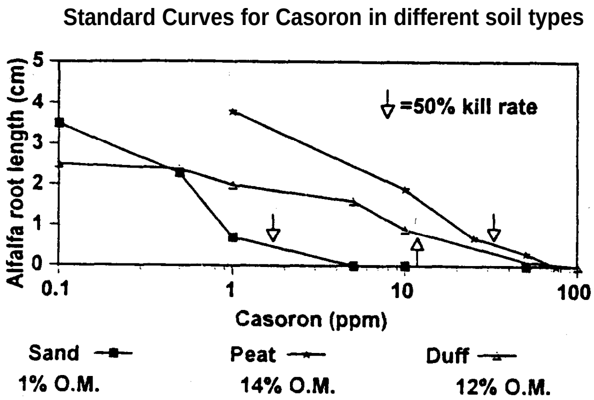


Figure 2. Standard curves (logarithmic scale) for the rate of Casoron required in different soils to prevent alfalfa root growth. Data indicate a ten-fold higher rate is required in soils with a 14% organic matter content than on sand.

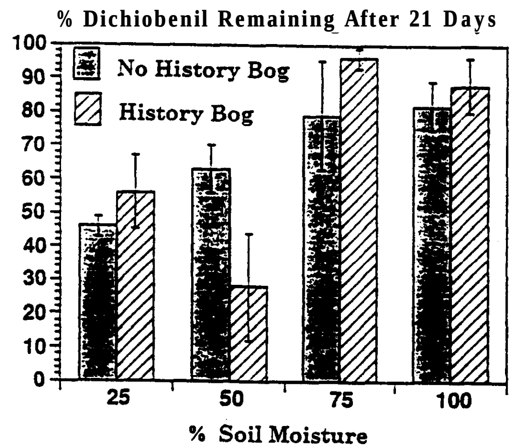


Figure 3. Effect of soil moisture on recovery of Casoron (Dichlobenil) after 21 days of incubation in two different cranberry soils--one with recent Casoron use (history bog), the other without Casoron for several years (no history bog). Twenty-five percent and 50% moisture are unsaturated soil conditions; 75% and 100% moisture are saturated soil conditions. Data provided by Dr. Allan Felsot, Food & Environmental Quality Lab, WSU- -Tri-Cities.

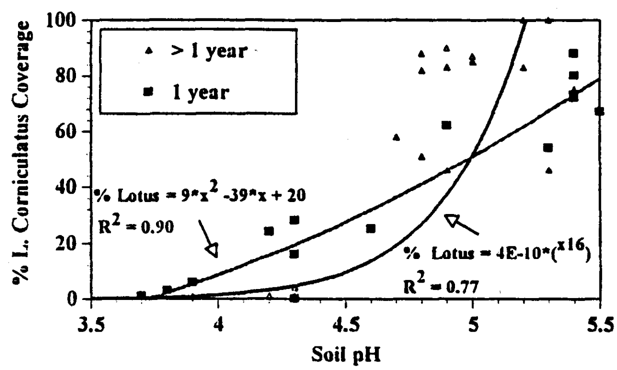


Figure 4. Percent Birdsfoot Trefoil (Lotus corniculatus) coverage in a cranberry bed as a function of the soil pH. Soil pH values after one year of sulfur treatment indicated Trefoil ceased to be a problem below pH 4.0. Soil pH values in the second year of treatment indicated that no Trefoil occurred below a soil pH of 4.5.

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# HERBICIDE EFFECTIVENESS ON WEEDS IN CRANBERRIES[1]

1-96

| | | Soil Applied Herbicides | | | | | Postemergent Herbicides | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| WEED FAMILY | | Princep | Evital | Casoron | Devrinol | 2,4-D | Roundup | 2,4-D | Poast | Prism[2] |
| Amaranth(Pigweed) | Pigweed, redroot | G | F | G | G | G | G | G | P | P |
| Buckwheat (Knotweed) | Dock, broadleaf | P | | G | | | G | G | P | P |
| | Knotweed | G | G | G | F | F | G | P-F | P | P |
| | Smartweed | G | F | F-G | G | F | G | G | P | P |
| | Sorrel, red | | G | G | G | F | G | | P | P |
| Buttercup | Buttercup | P | P | F | G | F | G | F-G | P | P |
| Composite | Aster, purple | | | F-G | F | | | | P | P |
| | Dandelion[3] | * | * | G | *P | G | G | G | P | P |
| | Goldenrod, western | | | | P | | G | | P | P |
| | Groundsel, common | F | F | G | G | | G | G | P | P |
| | Hawksbeard, bristly | | | G | P | | G | P | P | P |
| | Pineappleweed | F | G | G | G | F | G | | P | P |
| | Prickly lettuce | G | | G | G | | G | G | P | P |
| | Ragweed, common | G | F | G | F | | G | G | P | P |
| | Salsify, western | | | | P | | | | P | P |
| | Sowthistle | G | F | G | G | | G | G | P | P |
| | Spanish Needle (beggarstick) | G | P | G | P | | G | | P | P |
| | Tansy ragwort | | | G | P | | G | G | P | P |
| | Thistle, common | * | | G | P | F | G | G | P | P |
| | Thistle, Canada | P | G | F | P | F | F | P | P | P |
| Evening Primrose | Fireweed | G | | G | P | | G | F | P | P |
| | Yellow weed | | | F-G | P | P | G | G | P | P |
| Ferns | Bracken fern | P | P | F | P | P | F-G | P | P | P |
| | Sword fern | P | P | | P | P | P-F | P | P | P |
| Figwort | Speedwell | | | | | P | G | F | P | P |
| | Toadflax | | | P | P | | P | P | P | P |
| Geranium | Geranium, cutleaf | | | G | G | | G | F | P | P |
| Goosefoot | Lambsquarter | G | G | G | G | G | G | G | P | P |
| Grass (annual) | Barnyardgrass | F | G | G | F | P | G | P | G | G |
| | Bluegrass, annual | G | G | G | G | P | G | P | P | G |
| | Bromes, annual[3] | G | G | G | G | P | G | P | F-G | G |
| | Velvetgrass | P | G | | P | P | | P | F-G | P |
| Grass (perennial) | Bentgrass | * | * | G | * | P | G | P | F | G |
| | Rice cutgrass | P | G | F | G | P | G | P | F | G |
| | Saltgrass | P | F-G | P-F | P | P | G | P | F-G | G |
| | Quackgrass | P | P-F | G | P | P | G | P | P | G |

| WEED FAMILY | | Soil Applied Herbicides: Princep | Evital | Casoron | Devrinol | 2,4-D | Postemergent Herbicides: Roundup | 2,4-D | Poast | Prism[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| Horsetail | Field horsetail | P | P | G | P | P | P | G | P | P |
| | Scouring rush | P | P-F | G | P | P | P | G | P | P |
| Madder | Bedstraw | | G | | | | P | P | P | P |
| Mint | Henbit | G | G | G | P | F | G | F | P | P |
| Legumes | Clovers[3] | P | P | F | F-G | P | F | P-F | P | P |
| | Lotus/brdsft trefoil | P | P | P-F | F-G | P | P | P-F | P | P |
| Mustard | Bittercress, little | F | G | G | G | | G | G | P | P |
| | Cress, hoary | * | | G | | | | | P | P |
| | Pepperweed | * | | F-G | | G | G | G | P | P |
| | Mustard, wild | G | G | G | G | | G | G | P | P |
| | Shepherdspurse | G | G | G | P | G | G | G | P | P |
| Nightshade | Nightshade | G | G | G | P | | G | G | P | P |
| Pink | Chickweed | G | G | G | G | F | G | G | P | P |
| | Corn spurry | G | | G | G | | G | P | P | P |
| Plantain | Plantain | P | G | G | P-F | G | G | G | P | P |
| Purslane | Minerslettuce | G | G | G | P | | G | G | P | P |
| | Purslane, common | G | F | G | G | F | G | F | P | P |
| Rose | Silverleaf | P | P | P-F | * | P-F | F-G | G | P | P |
| Sedge | Sedge species[3] | P | F | G | P | P | F | P | P | P |
| | Nutsedge/yellow | F | G | P | G | P | P-F | P | P | P |
| Rush | Arrowgrass | P | P | P | P | F | | G | P | P |
| | Rush species[3] | P | F-G | F-G | F | F | F-G | G | P | P |
| | Lousegrass/toadrush | | G | G | F | | G | G | P | P |
| St. Johnswort | St. Johnswort | | | G | P | | G | F | P | P |
| Woody Plants | Alder | P | P | P | P | P | G | G | P | P |
| | Blackberry[3] | P | P | P | P | P | G | F | P | P |
| | Poison oak | P | P | P | P | P | G | F | P | P |
| | Salal | P | P | P | P | P | P | F | P | P |
| | Salmonberry | P | P | P | P | P | G | P | P | P |
| | Scotchbroom & gorse | P | P | P | P | P | G | G | P | P |
| | Willow[3] | P | P | P | P | P | F-G | F-G | P | P |

[1]This chart is intended only for planning your weed control program. Weed control will depend on timing, rates, environment and stage of weed development. Use herbicides with care; always check the label before using. Apply only to plants and sites listed on the label and use only the application methods and rates listed on the label. Herbicides listed are those registered for cranberries in Washington and Oregon for 1996. IS is advised to use up existing stock of Princep as use in future years may be canceled.

[2]Herbicide registered on non-bearing bogs only.

[3]There are numerous species of this plant.Herbicide effectiveness will depend upon which species is being treated; some species may be resistant.

(*) = Seedling control only; G = good (80-94%); F = fair (60-79%); P = poor (less than 59%)