plants and Ca is immobile (7). The data in Table 2 support the mobility of these mineral nutrients and show that under conditions such as reported herein, Ca is also mobile.

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PHYSIOLOGICAL ACTION OF OXYFLUORFEN (GOAL)

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Goal® (oxyfluorfen) is a diphenyl ether herbicide with broad spectrum preemergence and postemergence activity. It was discovered and developed at the Rohm and Haas Research Laboratories, Spring House, Pennsylvania. Goal was first syn-

thesized in 1971, and initial field testing was conducted in 1972, under the experimental code RH-2915. The first projects selected for field development was preemergence weed control in soybeans and post-directed applications for witchweed control in field corn.

The first commercial registration in the United States was approved by the Environmental Protection Agency (EPA) in May, 1979, for non-bearing fruit trees. In December, 1980, the registration was expanded to include bearing fruit trees. Conifers were added to the label in 1979; soybeans and corn in 1981; cotton, spearmint, and fallow bed in 1982; onions in 1984, and artichokes in 1985. Goal has rapidly filled many niches in modern agriculture, and new uses continue to be developed. An experimental use permit was granted in July, 1985 for use of Goal on cabbage, cauliflower, and broccoli. Work is currently underway to obtain registration for Goal in pine to be used in reforestation programs, horseradish, strawberries, tomato row middles, and garlic.

Outside of North America, Goal is reistered on numerous other crops. It is curently used in the production of sugar cane, rice, tea, coffee, eucalyptus, African palm, banana, plantain, rubber, avocado, mango, pineapple, kiwifruit, olive, and tung.

Herbicidal Activity. The mechanism of action of the diphenyl ether herbicides is not clearly understood at this time. Several theories ahve been proposed. We do know that Goal interferes with photosynthesis, and a toxic radical is generated in plant tissue. Light and chloroplasts must be present for this to occur. These radicals disrupt the structure and function of plant cell membranes. Membranes are no longer capable of compartmentalizing degrading enzymes. In a postemergence application this becomes apparent as water-soaked spots on leaves rapidly turn to necrotic lesions.

As a preemergence application, Goal works as a soil surface-barrier herbicide. As mentioned above, the presence of light is necessary for the activity Goal. This activity centers at the soil surface, where the presence of light and Goal cause the formation of the toxic radicals in the seedlings that cause rapid destruction of the weed seedlings. Since this process occurs at the soil surface, any practices that result in redistribution or disturbance of the soil surface after treatment will decrease the herbicidal effectiveness of Goal.

The selection action of Goal is also not fully understood. Tolerant species, such as conifers, probably are capable of neutralizing Goal by breaking it into non-active metabolities. Inability of Goal to penetrate leaves of resistant plants may also be a factor in selectivity. Goal, with its selective, broad

spectrum control is generally more active against broad-leaved weeds than grasses.

Important weeds controlled by Goal include groundcherry, teaweed, velvetleaf, nightshade, malva, filaree, redroot pigweed, witchweed, large crabgrass, barnyardgrass, goosegrass, and giant foxtail. Of particular interest to the nursery industry is the preemergence and postemergence control of common groundsel, dog fennel, prostrate knotweed, prickly lettuce, wild mustard, red sorel, bittercress, lambsquarters, morning glory, purslane, shepherdspurse, birdseye speedwell, and scarlet pimpernal.

Use on Conifers. Goal 1.6E can be used on conifer seed beds as a preemergence application at 1.25 to 5 pts./A. Goal should be applied after seeding but prior to conifer germination. Beds should be irrigated immediately after application with ½ to ¾ inch of sprinkler irrigation for maximum activity.

On conifer transplants and container stock, preemergence and postemergence control of weeds is obtained with applications of 5 to 10 pts. of Goal 1.6E/A. Optimum weed control is obtained when applications are made to weed-free containers or transplants. Postemergence applications should be made to weeds less than four inches high.

Goal 1.6E should be applied to dormant conifers. Applications to plants that have not fully hardened off or applications just prior to or after bud break can cause injury. This is due to the possibility that Goal, under certain conditions, violatilizes, or moves off the soil, and adversely affects crop foliage. This volatility is enhanced by wet soil, bright sun, and low relative humidity. These Goal volatility symptoms are dependent upon the rate of Goal used, the degree of volatility and, most importantly, the stage of crop growth (young, immature foliage is more sensitive than older, more mature foliage).

Application. Goal is quite surface-stable and can remain on the soil surface from 3 to 4 wks. without incorporation by rainfall or sprinklers. Irrigation, however, should be applied as soon as possible after application to maximize crop safety and weed control. In the southeast U.S. applications to dormant stock in December and February have been effective.

Goal has a low solubility in water (less than 0.1 ppm at 25°C) and is strongly adsorbed by organic matter and clay particles in the soil. These characteristics keep it from moving out of the treated soil.

Since activation occurs within chloroplasts and requires light, there is no root activity with Goal. Goal also is not translocated in the plant.

Herbigation has the potential for increasing crop tolerance

to applications of Goal 1.6E while reducing costs of application. The large volumes of water used in this type of application reduce the response of ornamentals to foliar applications of Goal 1.6E. The herbicide application can be immediately followed by a water rinse, which will wash the herbicide off nursery stock and provide additional safety. Application by herbigation should be made to relatively clean plantings; otherwise the postemergence activity of Goal will be reduced. Irrigation systems utilized for herbigation must provide a uniform application of water over the entire treated area in order to provide an accurate application of herbicide and consistent weed control.

On September 26, 1985 the EPA approved an expanded conifer label. Now included for use on conifer seed beds are: fraser, grand, and noble firs; eastern hemlock; jack, lodgepole, shortleaf, slash, mugho, Austrian, longleaf, ponderosa, Monterey, eastern white, Scots, loblolly, Virginia, and Himalayan pine; Douglas-fir; Norway, dwarf Alberta, blue and Sitka spruce.[1]

Conifer transplants and container plants that can be treated include yews, western hemlock, red cedar, five species of juniper, and two species of arborvitae, as well as those listed for seed-bed treatment.

Additional conifers as well as broad-leaved species will be added to the label as sufficient data are accumulated and sorted out.

[1]Firs:
Abies fraseri
A. grandis
A. procera

Hemlock:
Tsuga Canadersis

Pines:
Pinus banksiana
P. contorta
P. echinata
P. elliottii
P. mugho
P. nigra
P. palustris
P. ponderosa
Pines (cont.)
Pinus radiata
P. strobus
P. sylvestris
P. taeda
P. virginiana
P. wallichiana
[syn. *P. griffithii*]

Douglas fir:
Pseudotsuga menziesii
Spruce:
Picea abies
P. glauca
P. pungens
P. sitchensis