**Recommendation**

The use of a biological barrier in conjunction with a root-killing chemical barrier is worthy of trial in those locations where a pulled and treated site may be subjected to burrowing nematode reintestinations from adjoining groves.

**Literature Cited**


**Herbicides Used in Florida Citrus Groves**

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**Abstract**

Diuron and bromacil, pre-emergent herbicides, and the contact material, bipyridinium, have been used alone and in combination in large scale field trials during the past 2 years and terbacil for the past year on a variety of soil types for control of a number of weed populations. Application equipment has also been designed, constructed and modified to make the use of these materials more effective. When used in combination with bipyridinium, the results obtained with the pre-emergent materials have been generally superior to results obtained with either material alone. In some areas it is apparent that 2 or more applications a year are needed. Timing of the application may be critical to control obtained in some areas. No attempt was made to determine the possible accumulation of residual chemicals in trees or soil. However, there was no evidence of this during the time of these trials.

**Introduction**

Weed control is one of the chief management problems in young citrus groves. With labor in short supply and expensive, and the cost of maintaining tractors and hoe machines rising, herbicides offer an alternate method of weed control.

Herbicides have been available for use in citrus groves for several years. However, their use on a large scale was not justified without extensive preliminary field trials by growers under conditions peculiar to their plantings. Successful use of herbicides requires a knowledge of the weed species, soil types, application equipment and vigor of the grove and age of trees in which they are to be used. Proper instruction and constant supervision are also important to successful herbicide use.

In cooperation with growers, the authors established a number of extensive field trials in most citrus areas to evaluate materials and equipment. Groves were selected in each area to include all major soil types, scion variety and rootstock and tree age. In a few groves herbicides were applied prior to tree setting as well as immediate post planting. This paper summarizes the observations made during and subsequent to these trials.

**Weed Problems**

Two basic weed problems occur in Florida citrus groves: (1) the annual broadleaf and grass association with an occasional perennial grass species such as bermudagrass; and (2) an association of annual and perennial grasses. The former is characteristic of the interior ridge area while the latter is typical of the new flatwoods and coastal plantings. There are intermediate situations, products of local environments, that require modification of general recommendations.
Materials

Diruon, bromacil and terbacil were the principal pre-emergent materials used in these trials. They were applied alone and in combination with bipyridinium, a contact herbicide. Other herbicides were available, but no attempt was made to evaluate them in these field trials.

Rates of application were varied with the particular soil conditions and weed populations. Diuron was used at 4 to 8 pounds per acre, bromacil at 2 to 8 pounds per acre, and terbacil at 2 to 5 pounds per acre. Each of these materials contained 80% of the active herbicide. Bipyridinium was used at 1 and 2 quarts per acre. Also, non-ionic surfactants were used to insure good wetting of all weed species.

Method of Application

A boom of the type illustrated in Figures 1 and 2 was used in most of these field trials. The particular applicator was developed as the result of difficulties encountered in early trials with available equipment. Many growers have adopted the basic design of this boom for their needs; it is inexpensive to construct and can be fabricated in any farm shop.

The boom was constructed from a 48- to 54-inch length of 6-inch diameter steel pipe with a section removed so that the leading edge was low enough to afford protection to the spray nozzles from existing weed cover, stubble and low tree branches. The spray nozzles and spray pattern are visible to the operator so a nozzle malfunction can be detected immediately. Nozzle spacing has varied from 8 to 10 inches. Booms built in the last year have nozzles set on 8-inch centers, beginning 5 inches from the tip of the boom. This spacing resulted in better distribution and spray coverage of the treated area, especially where weed cover was present at the time of treatment.

An adjustable nozzle was used at the end of the boom to insure spray coverage at the base.
of tree trunks and to provide 4 to 5 inches clearance between the end of the boom and the tree to avoid debarking trees. Each nozzle except the swivel nozzle was equipped with a nylon TeeJet diaphragm shut-off valve that operates at 5 or more pounds pressure.

Nozzle tips such as TeeJet 8006 or equivalent used without strainers were most satisfactory. With vigorous mechanical agitation, clean water and cleaning of the line strainer twice a day together with a flushing of the whole system at the same time is the simplest way to avoid time loss in the field.

The boom was constructed and mounted so that its height at the vertical pivot point could be adjusted up or down 5 to 6 inches to compensate for the contour of the area treated, especially when used in bedded groves. The fixed wheel, size 14 x 4.5 x 6, mounted on the leading edge of the boom, proved invaluable for maintaining a constant boom height of 10 inches regardless of the terrain over which the boom passed. The boom that proved most satisfactory was not equipped with a "breakaway" joint.

Materials were applied with the use of this boom at 20 pounds pressure provided by a piston pump. Pressures higher than 20 psi are unnecessary and will in fact, cause drift problems. A quick opening valve and a 100-pound pressure gauge were mounted so they were readily visible and accessible to the operator.

Application of more or less material than required can be a costly mistake. For this reason, we emphasize the need for accurate tractor speed, care in calibration of the unit, and frequent recalibration to check for nozzle wear or malfunction of tachometers, pressure gauge, valves, etc. New spray units are often mounted on old and worn tractors, the speed of which is difficult to set and maintain. An accurate tachometer is necessary and the tractor should be checked over a measured distance in the grove where the unit is to be used, not in the shop area or on a roadway.

Figure 2.—End view of herbicide boom showing some details of construction.
Most critical to successful weed control is the selection of the operator for the application unit. He should know his equipment well, the reason for using it and how to use it. He should know something about the materials, the rate to apply, and the number of trees he should treat per tank of spray applied. Successful weed control and economical use of herbicides demand an operator who is more than just a tractor driver.

Table 1 should be referred to frequently as a check on the accuracy of the application. Applications within a 5% tolerance above or below these figures is usually acceptable.

Field Trials

Large scale field trials with plots of one or more acres in size have been established during the past 2 years in Polk, Hardee, Brevard, Okeechobee, DeSota, St. Lucie, Martin, Dade and Palm Beach counties on various soil types. Treatments in the form of 8-foot strips in the tree row were made from January to September. Periodic observations were made to determine the extent of weed control and tree tolerance from the standpoint of practical grove management.

RESULTS AND DISCUSSION

All the materials used in these trials have, at one or more rates, given satisfactory control that most growers want at an economical and acceptable cost. For example, the cost of mechanical and hand hoeing in one acre of a field trial was about $0.57 per tree for one year while the cost of herbicides on an experimental basis averaged $0.22 per tree (including an inflated application cost inherent in experimental work) for 7 months of weed control. Perennial grass was the principal problem and bromacil was used at 4, 6 and 8 pounds per acre in combination with bipyridinium at 1 quarts per acre. No tree injury was observed except a mild leaf pattern at the 8-pound rate. The savings realized did not include certain hidden benefits that result from herbicide use and the elimination of frequent damage by mechanical cultivation.

Our observations indicated that diuron should not be used where perennial grass is evident even as sparse growth for when broadleaf and annual grasses were suppressed the perennial grasses became a problem because competition had been eliminated. This happened in both ridge and coastal areas. One solution to this problem was to use combinations of 2 or more materials. Diuron at 4 pounds and either bromacil or terbacil at 2 pounds per acre have been successful in the ridge area in eliminating a potential perennial grass problem before it developed. Addition of bipyridinium contact herbicides has further increased the degree of control, especially in areas where clean cultivation has been difficult to establish prior to making the application.

Combinations of bipyridinium plus either diuron, bromacil or terbacil gave better control than either material used alone. Both bromacil and terbacil have inherent burn-down properties and do have a striking effect on established weeds; however, our observation indicate the combination gives more complete control for a longer period.

Of the 4 materials used in these trials, no one material can be considered as "best." All 4 have specific uses for specific problems. Of the 4, only diuron, bipyridinium and terbacil are presently labeled for use in citrus groves in Florida.

Bromacil suppressed weed growth equally as well as did terbacil or diuron. However, trees in bromacil plots often expressed mild vein chlorosis symptoms similar to those produced by diuron. Results obtained in any single period were similar in all areas. However, all materials gave a longer period of control when applied in January or February than when applied in June, July or August. January or February applications generally gave good weed control for about 6 months while June, July and August applications generally gave equivalent weed control but for about 3 months. This was particularly true in areas that received 14 or more inches of rain.

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It has been difficult to establish optimum times for applications and optimum amounts of material to apply per application. Thus, further trials on timing of applications and dosage are necessary in all citrus growing areas before specific recommendations are made.

Properly used, herbicides can be extremely useful to growers. Reduction or complete elimination of mechanical injury to young trees can be accomplished as one of the side benefits. This will probably mean less foot-rot as well as reducing costly tree replacement. Surface feeder roots will not be pruned as is often done with mechanical weed control equipment and thus the grower can expect better tree growth. Herbicide are, by their nature, phytocidal—plant killers, thus, those who use them should do so with knowledge, discretion and care.

**POPULATION FLUCTUATIONS OF BURROWING NEMATODES IN FLORIDA CITRUS GROVES**

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**ABSTRACT**

The population of burrowing nematodes, *Radopholus similis*, in rough lemon *Citrus limon* (L.) Burm. rootlets was found to vary between samples, depths, months, and years, but there was a recognizable annual period of high populations. Highest populations recurred from October through December. Lowest populations recurred from January through July. The population of burrowing nematodes virtually disappeared during the spring so that it became difficult to find nematodes in areas of known infestation. Although highest populations always occurred during the same season, the month when peak population was reached varied from grove-to-grove and from year-to-year.

**INTRODUCTION**

In citrus groves, the populations of burrowing nematodes, *Radopholus similis* (Cobb) Thorne 1949, are constantly fluctuating. During investigations on burrowing nematodes, the cause of spreading decline in citrus, it was observed that more burrowing nematodes could be found on the roots of trees recently infested than trees that had been parasitized for 2 or more years (6). Populations also varied with depth; low populations occurred near the soil surface, and highest populations from 2 to 5 feet deep (3, 9, and 10). It was also noted that burrowing nematodes could at times be easily isolated (2) and later virtually disappear. Populations became so low that the nematodes could not be readily detected in areas of known infestation and repeated sampling of such areas was necessary before the parasites were isolated. These fluctuations in numbers of burrowing nematodes prompted a study to determine if population changes were cyclical, and the size and frequency of high and low populations.

**MATERIALS AND METHODS**

Observations on the influence of time of year and soil depth on the numbers of burrowing nematodes in soil and citrus roots were made from 1 quart samples of soil and citrus rootlets collected 1, 1.5, 3, and 4 feet deep in citrus groves known to be infested. Burrowing nematode population counts were made twice a month from February 1954 to June 1955. The mean number of burrowing nematodes was determined for each depth and month. The percentage of samples containing burrowing nematodes was also determined for each depth.

The mean monthly populations of burrowing nematodes in citrus rootlets were determined from samples of approximately 10 to 15 grams of citrus rootlets collected from 6 to 36 inches deep in the soil. These samples were collected from different groves during 7 years. The number of rootlet samples collected ranged from 30 in June and September to 92 in October. All population data were from 20 to 30-year old...