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Vegetation Management in Row Middles in Florida Citrus[1]

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Control of weeds is a major economic factor in Florida citrus production due to a climate which allows year-round germination and growth. Weeds compete with citrus trees for water and nutrients, and during winter months can increase fire hazard and cold damage from radiation freezes. Vegetation management between the rows of trees in Florida citrus utilizes various methods to establish and/or suppress vegetation growth to minimize impacts on citrus production and harvesting practices as well as tree growth. The optimum row middle vegetation will minimize soil erosion, and be low growing, non-invasive into herbicide treated areas, easy to control either mechanically or chemically, thereby, minimizing competition with the citrus tree for water and nutrients. Middles vegetation should not harbor pests which can potentially interfere with the orchard production systems. Methods of vegetation management in row middles include mechanical (cultivation and mechanical mowing), chemical and chemical mowing/wiping. Cultivation controls weeds efficiently and economically but damage to the limited root system of the citrus tree may occur, especially in bedded orchard systems. Chemical weed control kills emerging weed seedlings with preemergence herbicides or emerged weeds with postemergence herbicides. Chemical mowing, when used in combination with mechanical mowing, utilizes low rates of glyphosate herbicide to suppress vegetative growth for 45 to 90 days in the row middles. Whereas wiping technology applies concentrated glyphosate to tall growing species, leaving lower-growing species unaffected.

Middles management programs in Florida citrus involve various methods to establish and/or suppress vegetation in areas between tree rows. Optimum row middle vegetation minimizes soil erosion from rain and wind, is low growing, non invasive into herbicide treated areas, and is easy to control mechanically or chemically while not competing with the citrus tree for water and/or nutrients. Methods to control vegetation includes mechanical, chemical, and chemical mowing/wiping.

Local climate greatly affects vegetation growth, with areas of relatively high rainfall and heavier soils having greater vegetation pressure. Soil types, especially poor sandy soil, effect vegetation species present and the extent to which vegetation competes with citrus trees. Heavy soils have a greater nutrient and moisture holding potential which can be shared between grove floor vegetation and citrus trees.

Vegetation species vary greatly in ability to compete with citrus. In general, grass species, especially sod-forming ones, are more aggressive competitors than broadleaf weeds (Tucker and Singh, 1999). Mowed grasses can be more competitive than unmowed because of the demands of regrowth for nutrients and moisture. Chemically mowed areas retain higher soil moisture levels than areas under other treatments (Tucker et al., 1997). Under Florida

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conditions, it is not economically feasible nor desirable to remove all vegetation from row middles.

This document addresses the area of vegetation management in row middles as opposed to weed management in tree rows. Depending on the width of the herbicide treated area under the tree canopy, the area remaining will be mechanically and/or chemically mowed or to a lesser extent, mechanically tilled. Approximately 44 to 68% of the total grove hectareage is under a middles management program for mature or young orchards, respectively, with the remaining hectareage generally chemically treated to keep the area under the tree canopy free of vegetation. In Florida the cost for managing vegetation in the row middle ranges from approximately $110 to $160 per ha per year or around 5 to 7% of the annual production costs (Muraro, 2000). Actual costs will vary depending on middles width, climate, soil conditions, orchard layout (bedded vs. non bedded) and vegetation species.

The middles management programs can influence vegetation species present (Monsanto, 1996), soil moisture (Tucker et al., 1997), nutrient status (Rouse and Mullahey, 1992), soil erosion from wind and water (Jackson and Davies, 1999), climatic conditions (Krezdorn and Martsolf, 1984; Tucker et al., 1980; Tucker and Singh, 1993) and various biological factors (Knapp et al., 1982).

Grove Cover Crop Programs

Prior to establishing a new orchard, soil stabilization programs should be initiated to prevent soil erosion by wind or rain and sand blasting of newly planted trees. In many cases, temporary grass or broadleaf species are planted in the row middles as a cover crop to minimize soil erosion. Once cover crops reach maturity they may be incorporated into the soil to add organic matter and nutrients. Nitrogen-fixing leguminous crops such as hairy indigo (*Indigofera hirsuta* Harvey) and perennial peanut (*Arachis glabrata* Benth.) have been used to increase organic matter and add additional nitrogen to the soil (Jackson and Davies, 1999). Caution should be used in choosing cover crops since some harbor pests which can damage low volume irrigation systems in citrus orchards in central and southwest Florida (Childers et al., 1992). Cover crops as well as native vegetation will use additional water, and in areas where soil moisture is a limiting factor careful consideration should be used in selecting cover crop species to minimize moisture competition.

In orchards planted on raised beds, permanent sod cover crops should be established to maintain bed configurations, to minimize soil erosion and to move soil into drainage structures. Once the permanent sod cover is established, mechanical and/or chemical mowing will maintain vegetative plant growth height to an acceptable level.

Perennial peanut (*A. glabrata*), a warm-season perennial legume grown on well-drained soils of Florida and other Gulf Coast states, has primarily been utilized as a forage legume. The rhizomaeous peanut has good nitrogen-fixing ability, makes a low dense cover crop and does not require replanting once established. It develops a deep, extensive rhizome root system which enables it to survive in infertile, well-drained sands. The legume is native to South America and is being evaluated in Florida as citrus row middle vegetation. Nitrogen in excess of 180 $kgha^{-1}$ per year could be produced from the dry matter and from the nitrogen-fixing *Rhizobium* bacteria (Rouse and Mullahey, 1992). Advantages include the nitrogen contribution and reduced mowing requirements, while disadvantages include the need for propagation from underground stems or rhizomes, supplemental irrigation or rainfall for establishment, as well as weed control and fertilizer applications during establishment. The perennial peanut is easily damaged by plowing the soil. However, this is not frequently done in Florida except in major grove renovation.

Middles Management Programs

Mechanical Tillage

Extensive use of soil tillage in the early years was conducted with implements such as discs, choppers, mechanical hoes and hand hoes. Tillage is very economical and effective in severing stems and roots of vegetation species growing in the row middles, but provides only temporary control of vegetation. When tillage was the main method of vegetation management, five to six such operations were conducted each year as each new crop of weeds emerge and eventually produce seeds. The timing of each tillage operation usually has greater flexibility than the application of soil applied preemergence or postemergence herbicides. However, once seeds are produced and incorporated into the soil, they may remain viable for years with each tillage operation potentially exposing millions of additional seeds for subsequent germination. In some cases, control of deep-rooted perennial weeds may not be achieved with shallow cultivation, and may create solid stands of very aggressive species of bermudagrass (*Cynodon dactylon* (L.) Pers.), torpedograss (*Panicum ripens* L.), bahiagrass (*Paspalum notatum* Fluegge) or nutsedge (*Cyperus* spp.). Tillage has decreased rapidly and is only used to a limited extent in deep sandy soil locations.

In areas where citrus root systems are shallow and susceptible to damage from tillage equipment, it is estimated that upwards of 75 % of the root system may exist within the upper 30 cm of the soil profile (Noling, 1993). The majority of citrus roots grow directly under the tree canopy and decrease rapidly with distance from the trunk to tree canopy edge and row middles, beyond which tillage significantly reduces shallow feeder root abundance (Noling and Duncan, 1987). Tillage poses unacceptable levels of root damage especially where root systems are shallow on raised beds on poorly drained soils. Tucker et al. (1980) found that twice as many roots were found in 0 to 15 cm soil samples where herbicides were applied as compared to the tilled blocks. Damage to the tree trunks by tillage equipment also provides easy entry sites for soil-borne pathogens.

Where tillage is practiced, it has been noted that nighttime minimum temperatures under calm conditions are 1-2ºC higher than in locations with dense tall vegetation (Tucker et al., 1980). Vegetation insulates the soil and reduces heat loss from the soil surface by radiation. Freshly cultivated soil will not release as much heat as compared to bare compacted soils. Thus, trees surrounded by little or no vegetation may suffer less damage from marginal freezes compared to other vegetation management systems.

Best management practices (BMPs) have been established in the Indian River citrus production area of Florida (Boman et al., 2000) to encourage vegetation within all water furrows to prevent erosion and trap sediments that may enter the drainage system.

Mechanical Mowing

Mowing operations are intended to remove all vegetative growing portions of the plant usually at a height of about 15 to 30 cm and produce an aesthetically pleasing appearance. Vegetative growth will resume quickly after mowing if conditions are favorable for regrowth. Frequent mowing of tall-growing species will allow for establishment of lower growing species which may create a solid sod culture. Frequent mowing will not eliminate competitive demands for moisture consumption by vegetation species. Moisture availability should be considered when choosing mowing as the vegetation control method especially when orchards are subjected to drought conditions.

Energy demand and equipment maintenance is very high as compared to other vegetation control measures. Mowing vegetation prior to seed heads formation minimizes depositing seeds in the herbicide-treated areas under the trees. Plant stubble from large amounts of vegetative growth can create a fire hazard. Mowed surfaces can be 1 to 2ºC colder than a cleanly cultivated soil surface (Krezdorn and Martsolf, 1984) but may be 1 to 2ºC warmer than surfaces with excessive vegetation under calm conditions. Mowed surfaces utilize greater moisture than does either chemical mowing or cultivation (Tucker et al., 1997).

Chemical Mowing

Chemical mowing applies low rates of postemergence glyphosate herbicide to suppress vegetative regrowth of grasses and broadleaf weeds in the row middles for 45 to 90 days. After 45 days, vegetation will resume slow regrowth and should be mowed when vegetation regrows above optimum height at about 75 to 90 days and retreated for another 75 to 90 days of growth suppression. To get the maximum suppression of vegetative regrowth, the treated area should be mowed 1 to 2 weeks before re-application of glyphosate to vegetation with a height of 15 to 20 cm. The rate of herbicide applied will vary depending on the weed species present. For control of bahiagrass (*Paspalum notatum*) and bermudagrass (*Cynodon dactylon*) apply 320-660 and 660-970 ml glyphosate 4L, respectively, per treated ha (Futch and Singh, 2000). Applications of 93 to 230 $L \cdot ha^{-1}$ are standard with rates as low as 65 to 93 $L \cdot ha^{-1}$ allow for larger areas to be covered in a shorter period of time thereby increasing efficiency. Higher product rates may severely damage or kill vegetation which would allow other species to invade the area. Weed growth should be in an active state of growth and not drought stressed at the time of application. Rainfall within several hours may diminish the effectiveness of control.

Proper boom design and application pressure can minimize potential damage to low-hanging tree limbs and fruit. A flexible carpet or belt cover on the back of the boom should minimize drift of spray material.

Chemical Wiping

Chemical wiping applies glyphosate through a solution permeable carpet wiper or solution-panel wiper to kill tall-growing weed species and aid in establishing a desirable sod. A carpet wiper utilizes a modified spray boom which is wrapped with a porous-backed carpet type material. The spray material is applied on the back of the carpet, soaks through the carpet, and then is wiped onto the target weed at 2 to 4.7 $L \cdot ha^{-1}$ as a 5-33% solution. The panel wiper utilizes a dispensing system to apply 2 to 4.7 $L \cdot ha^{-1}$ as a 50-80% solution. The spray solution is applied evenly to a panel which passes over the target weed at a specified height. The panel wiper recirculates excess material to minimize dripping from the panel.

Filtration is critical to maintain even application of spray solution to the carpet or panel. Both type of wipers utilize a timer connected to the pump to regulate the flow of spray solution. The regulated flow maintains the carpet or panel at an even wetness for thorough coverage while minimizing excessive application to avoid dripping from the wiper surface.

Conclusions

A single middles management method will not provide adequate control over a wide geographical area as numerous weed species, soil types and environmental factors influence the vegetation present as well as its growth. Thus, growers must utilize a combination of methods to provide effective, environmentally sound, and economical vegetation control.

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