UF IFAS Extension UNIVERSITY of FLORIDA

HS717

Weed Management Principles in Commercial Vegetable Production[1]

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Weeds compete with vegetable crops for light, water, and nutrients. This competition decreases plant vigor, yield, and crop quality (Figure 1). They interfere with hand harvest and can complicate or prevent machine harvest. Weeds also serve as alternative hosts to diseases, viruses, and nematodes. Lists of weed hosts for viruses and nematodes are available in the EDIS documents "Common Weed Hosts of Insect-Transmitted Viruses of Florida Vegetable Crops" (ENY-863) and "Weed Hosts of Root-Knot Nematodes Common to Florida" (ENY-060). There are also a range of books and EDIS documents that can help identify weeds.

Figure 1. Wild radish interference in sweet corn
Credits: P. J. Dittmar

Two books that are helpful for the identification of weeds in Florida are *Weeds of the South* and *Weeds of the Northeast*.

The first step in weed management is frequent and proper scouting. Fields should be frequently scouted early in the production year when the crop is more susceptible to competition. Weed populations are greater along the edges of the field and will vary due to microecosystems in the field (e.g., wet spots or different soil types). Scouting should be completed in a zig-zag pattern across the field for the entire length of the field.

Proper identification and understanding of life cycles is important for selecting the correct method and timing of weed control. Weeds may be annuals, biennials, or perennials. Annual weeds emerge from seed, grow, and flower within a single year. Summer annuals emerge in the spring and grow through the heat of the summer months. Summer annuals include pigweed, morningglory, crabgrass, pusley, and goosegrass. Winter annuals emerge during the fall and grow during the winter months. Biennial weeds emerge from seed and grow during the first year but do not flower and produce seeds until after a dormancy period. Biennial weeds include wild carrot, cutleaf evening primrose, and common mullein. Perennial weeds can grow and produce flowers for multiple years. Perennial weeds produce

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vegetative structures (stolons, rhizomes, tubers, or large roots) that generate new plants. Perennial weeds include nutsedge, Bermuda grass, Brazil pusley, and creeping beggerweed.

Decision tools like economic thresholds and weed-free periods can guide the timing of weed control. The economic threshold is the weed density that causes a significant decrease in crop yield. The threshold is different for each weed/crop complex (Table 1). Weeds may be present in the field, but the loss in the crop yield from competition may be less than the expense of control.

The second guide for timing of weed control is based on the critical weed-free period. To determine the weed-free period, researchers plant the crop and remove the weeds that germinate at specific intervals during the crop year (Figure 2, blue line). Typically, removing the weeds later in the season has a negative impact on plant growth or yield. In other plots, the crop is kept weed-free for a specific interval then weeds are allowed to germinate. The weed-free period is typically early in the crop cycle when the crop is less competitive (Table 2). Weeds that emerge later in the season have less of an impact on the crop. A threshold is determined, usually 5% or 10%, and a weed-free period is determined based on the period when plant growth is above the threshold. The weed-free period is the time required for the field to be weed-free for optimum plant growth or yield. Transplanted crops can become established and competitive more quickly than directly seeded crops.

Weed management practices can be separated into five categories: preventative, cultural, mechanical, biological, and chemical. The most successful weed management programs will incorporate more than one type of weed control.

Preventative

The first step is site selection. Select a field with low weed populations and treat areas with problems such as poor drainage prior to crop establishment. Control or mow the weeds at the edges of fields or irrigation furrows to prevent seed formation. Seeds can be moved by equipment, wind, animals, and water, and may spread throughout the field. Weed seed can also move between fields on tractors, blades of cultivators, heads of harvest equipment, and other methods. All equipment should be cleaned after completing a task in a field with a high weed population. When possible, limit travel in the field to periods when weed seeds are not mature, and work your cleanest fields first and move toward the ones with the greatest weed populations. Purchase crop and cover crop seed from reputable sources to limit the amount of weed seed contamination.

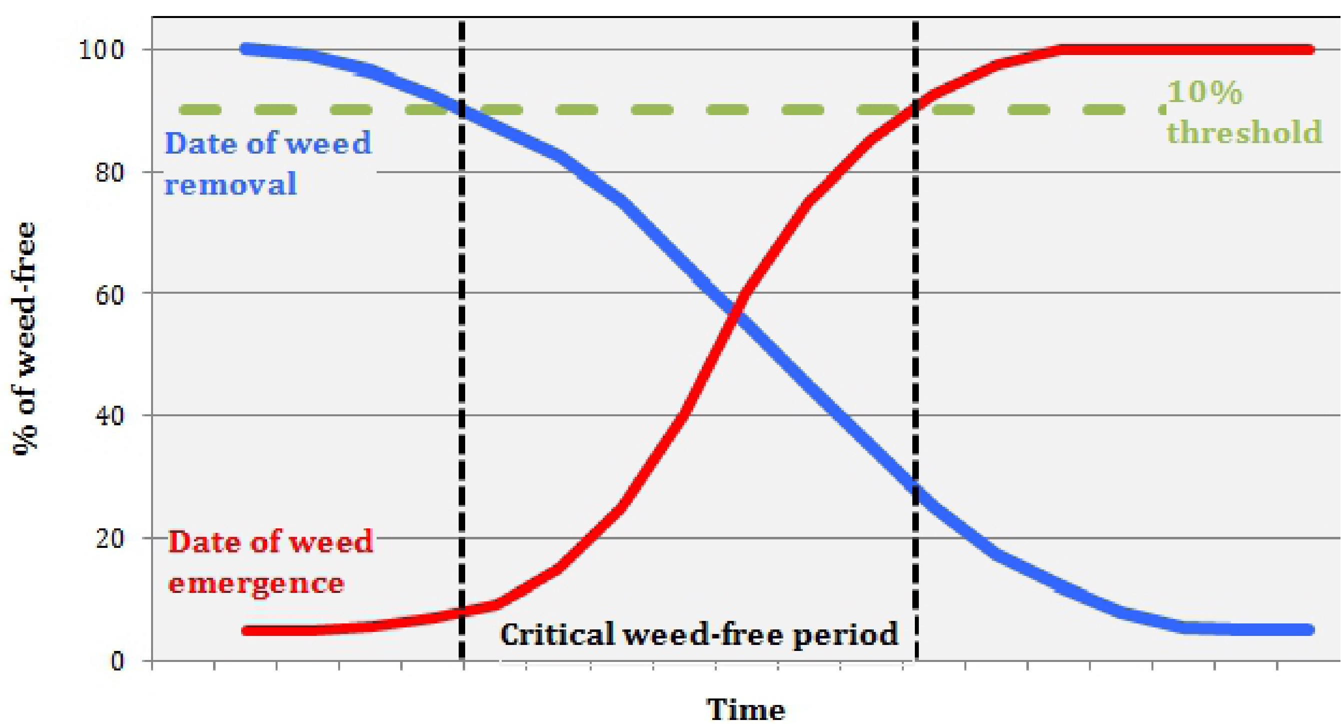

Figure 2. Example of a critical weed-free period using a 10% reduction threshold. The critical weed-free period is the time between the black lines when crop growth or yield is below 100% of the weed-free. Weeds removed before or weeds that emerge after the critical period have >90% growth of the weed-free.

Cultural

A healthy crop is important for competing against weeds. Use healthy transplants or seed with excellent germination to insure quick canopy closure. Plants stressed by improper watering (too wet or too dry), diseases, or nematodes are less competitive (Figure 3). Proper nutrition is important: minimize fertilizer in the row middles where crops won't benefit but weeds will. Select the proper row spacing to allow for quicker canopy closure.

Figure 3. A wet low area of the field decreasing potato health and grass weeds emerge in the row middles
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Crop and variety selection has an impact on weed growth. Crops that are tall or have large leaves shade the soil surface and prevent weed seed germination. Crops such as cabbage, bean, and corn are very competitive crops. Onions and carrots allow more light to the soil surface and are less competitive. The same principal of light penetration to the soil surface can be applied to crop varieties: a compact variety will be less competitive compared to other varieties with larger growth habits.

Multiple vegetable crops are grown with polyethylene mulch as part of the cultural practices. The horticultural benefits of plasticulture are reduced water loss, better nutrient management, and a barrier for fumigation. The weed management advantage is the control of grass and broadleaf weeds. The plastic mulch prevents light penetration to the soil surface and inhibits weed germination. White plastic allows light, so select mulch that has a black underside to prevent light penetration. Grass and broadleaf weeds still grow in the crop holes, and yellow and purple nutsedge can pierce through the plastic mulch.

Repeating the same crop for multiple years with the same weed management control will select for certain weed species. Crop rotation allows for different weed control options to be used in the field. Choose a rotation based on crop competitiveness, use of mulch or cultivation, and different herbicide modes of action. Observe plant back restrictions of herbicide or injury that may occur in the crop that follows.

Cover crops should be included in the crop rotation. These shade the soil surface and prevent weed germination. Some cover crops, such as rye, have allelopathic compounds, which are plant chemicals that prevent seed germination. Additional information can be found in EDIS publication HS387 "Annual Cover Crops in Florida Vegetable Systems Part 1. Objectives: Why grow cover crops?"

Mechanical

Mechanical weed control includes plows, cultivators, mowers, hoes, and hand-weeding. Chisel and moldboard plows are used at the beginning of the season and cultivate deep into the soil profile. This process buries weed seeds below the germination zone. Light cultivation with a field cultivator controls small weeds by cutting the weeds and is shallow to prevent weed seeds from being brought to the soil surface. A single cultivation provides excellent control of annual weeds; however, cultivation may break apart pieces of perennial weeds and cause the weed to spread. Repeat cultivation is important to encourage continuous growth, which reduces the carbohydrates in the storage structure of the weed.

Basket, tine, or finger cultivators lightly disturb the soil surface and control small weeds by breaking roots or foliage. Basket cultivars will provide control in the row

Figure 4. Weed control in the row middles with a basket cultivator, nutsedge is still in the crop row
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middles, however, weed control in the crop row will be minimal (Figure 4). Tine or finger cultivators may provide better weed control in the crop row.

Use mechanical weed control only when it will be most effective, because mechanical weed control degrades soil structure, dries the soil surface, and prunes crop roots.

Biological

Biological control relies on biological agent to damage a weed species. This method uses insects, plant pathogens, or animals. Several control agents are host specific, controlling certain weed species (e.g., the TSA beetle (*Gratiana boliviana*) for tropical soda apple, and the leaf mining fly (*Hydrellia pakistanae*) or the tuber weevil (*Bagous hydrillae*) for hydrilla). Because of these narrow feeding habits, this method is typically used in natural and aquatic areas for a single invasive species. Other biological agents consume several species (e.g., goats and grass carp). This can be difficult to manage if the crop species is also consumed. Biological control is not used in vegetable production due to the multiple weed species in the field; however, research is being conducted and new techniques may emerge in the future.

Chemical

Proper herbicide selection can be an effective weed control tool. Herbicides are classified by their mode of action, which is how they affect plant growth. Herbicides are separated by application placement, selectivity, and translocation.

Application placement includes foliar- or soil-applied herbicides. Foliar-applied herbicides control the weeds after emergence above the soil surface (postemergence). Proper coverage of the foliage is important for foliar applied herbicides, and a surfactant is often required for proper absorption of the herbicide. Soil-applied herbicides control the weeds before emergence above the soil surface (preemergence). Soil-applied herbicides are applied to the soil surface or require incorporation into the soil surface. Incorporation reduces vaporization of certain herbicides or places the herbicide closer to the weed seed. Incorporation methods include irrigation, rainfall, or light cultivation. Poor incorporation will result in reduced efficacy.

Herbicide selectivity results in control of a specific type of weed such as broadleaf or grass weeds only. Auxin herbicides (2,4-D, clopyralid) control broadleaf weeds only and are common in grass crops or turfgrass. Carfentrazone and certain sulfonylureas provide excellent control of broadleaf weeds with low to no injury to grass crops. Grass only/Gramineae herbicides/ACCase herbicides (clethodim, sethoxydim, fluaziflop) control only grass weeds and can be applied over the top of broadleaf weeds.

Herbicides can be grouped as translocating or contact herbicides. Translocating herbicides (glyphosate, halosulfuron) move from the contact point to another part of the plant. This is important when controlling perennial weeds, which require root death for complete control. Contact herbicides (carfentrazone, paraquat) kill the area around the contact point; complete coverage is important for these herbicides.

Herbicide-resistant weed species have become more problematic. Paraquat-resistant American black nightshade, paraquat-resistant goosegrass, and glyphosate-resistant Palmer amaranth have been documented or observed in Florida vegetable crops. To prevent resistance, growers should incorporate nonchemical control methods, rotate modes of action, choose products with multiple modes of action, use correct rates, and monitor constantly.

Other EDIS publications that provide information about herbicides for vegetables and fruits include “Estimated Effectiveness of Recommended Herbicides on Selected Common Weeds in Florida Vegetables” (HS706), “Calibration of Chemical Applicators Used in Vegetables” (HS1220), and “Factors Affecting Herbicide Use in Fruits and Vegetables” (HS1219).

Conclusion

For decades, the vegetable industry relied on methyl bromide for weed control. The phase-out of methyl bromide has proven that reliance on a single method of weed control can be detrimental to an individual field and the vegetable industry as a whole. The vegetable industry faces additional challenges to weed control. Erosion and fuel prices restrict the use of mechanical weed control. Immigration policies affect hand weeding. Herbicide resistance and public policy affect chemical control. A successful weed management program will incorporate multiple control practices with preventative, cultural, biological, mechanical, and chemical methods.

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Table 1. Effect of weed density on yield of various vegetable crops

Crop	Weed, population	Yield reduction	Reference
Bean, white	Hairy nightshade, 2 plants/m	105	Blackshaw 1991
Cabbage	Velvetleaf, 1.2 plants/m^2	52 to 76%	Miller and Hopen 1991
Lettuce	Common purslane, 16 plants/6 m of row	44 to 48%	Santos et. al 1997
Lettuce	Smooth pigweed, 2 to 4 plants/6 m of row	20%	Santos et. al 1997
Pepper, bell	Purple nutsedge, 0.63 plants/m^2	10%	Morales-Payan et al. 1997
Potato	Barnyardgrass, 1 plant/m	19%	VanGessel and Renner 1990
Potato	Redroot pigweed, 1 plant/m	22 to 30%	VanGessel and Renner 1990
Tomato	Purple nutsedge, 0.46 plants/m^2	10	Morales-Payan et al. 1997
Tomato	Common lambsquarters, 16 plants/m	17%	Bhowmik and Reddy 1988
Watermelon	American black nightshade, 2 plants/m^2	80%	Gilbert et al. 2008
Watermelon	Yellow nutsedge, 2 plants/m^2	10%	Buker et al. 2003

Table 2. Weed-free periods

Crop	Weed	Period[1]	Reference
Bean, white	Various	Second trifoliate to first-flower stages	Woolley et al. 1993
Cabbage, seeded	Velvetleaf	0 to 4 WAE	Miller and Hopen 1991
Cabbage, transplanted	Various	3 to 5 WAE	Weaver 1984
Cucumber, pickling	Various	0 to 36 DAE	Friesen 1978
Cucumber, pickling	Various	0 to 4 wk. after seeding or 3 to 4 consecutive wk.	Weaver 1984
Pepper, fall planting	Yellow nutsedge	2 and 7 WAT	Motis et al. 2004
Pepper, spring planting	Yellow nutsedge	3 and 5 WAT	Motis et al. 2004
Pepper, transplanted chili	Various	1.3 to 11.9 WAT	Amado-Ramirez 2002
Muskmelon, seeded	Smooth amaranth	1.0 to 3.9 WAE	Terry et al. 1997
Squash, summer	Various	4 to 6 WAE	Mallet and Ashley 1988
Sweetpotato	Various	2 to 6 WAT	Seem et al. 2003
Potato	Various	Planting to 25 d after flowering	Ciuberkis et al. 2007
Potato	Quackgrass	0 to 68 DAE	Baziramakenga and Leroux 1994
Tomato	Various	28 to 35 d. after transplanting	Weaver and Tan 1983
Tomato	Yellow nutsedge	3 to 6 WAT	Morales-Payan 1999
Watermelon, transplanted	Large crabgrass	0 to 6 WAT	Monks and Schultheis 1998
Watermelon, seeded	Smooth amaranth	0.5 to 2.97 WAE	Terry et al. 1997

[1] WAT= weeks after transplanting, WAE= weeks after emergence, DAE= days after emergence