STEPS TO SUCCESS:

1. Properly identify nuisance weeds.
2. Sanitation is critical to reduce introduction of new weeds.
3. For optimal weed control, kill weeds before they set seed.
4. Weed control is a farm wide concern, weeds in ditches and along roadways can cause a build up of diseases and insects.

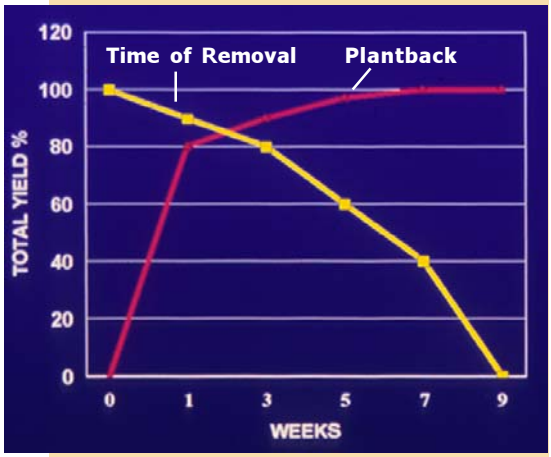

Figure 1. The graph demonstrates the total yield of watermelon and muskmelon from smooth amaranth (pigweed) interference. If the amaranth is removed (time of removal) 1 week after the crop is emerged or transplanted, the yield is 90% of the weed free crop (10% yield loss). If the weed emerges after 3 weeks (in the research plots we planted back), and grows in the crop the remainder of the season, less than 10% yield is lost. The critical period to keep the crop weed free so less than 10% yield/ loss is seen is 1-3 weeks after the crop emerges or is transplanted. Graph by: Bill Stall.

The bottom line is that the extent of weed interference with crops is influenced by:

- Weed species
- Weed population composition (mixed or pure stands)
- Time of emergence
- Time of removal

WHEN TO MANAGE WEEDS:

- Weeds reduce yield and quality of vegetables through direct competition of light, moisture and nutrients as well as by interference with harvest operations.
- Early season competition is most critical and a major emphasis on control should be made during this period.
- Weeds can be controlled but this requires good management practices in all phases of production. Because there are many kinds of weeds with much variation in growth habit, they obviously cannot be managed by a single method.
- The incorporation of several of the following management practices into vegetable production practices increases the effectiveness for controlling weeds.

CRITICAL WEED-FREE PERIODS:

- The critical period of interference (CPI) is the specific time interval during crop growth that a crop must be maintained weed-free to prevent interference from reducing yields **(Figure 1)**.
- CPI depends mainly on weed species, weed mixtures, weed density, crop species and crop planting method (direct seed or transplant).
- In transplanted tomatoes competing with multiple weeds or with troublesome individual weeds (pigweeds, nightshades, yellow nutsedge), the end of the CPI was usually at the early fruit set stage crop (5-7 weeks after transplanting (WAT)), although with purple nutsedge the end of the CPI was up to 9 WAT.
- For a given yield loss threshold in a particular crop, the minimum weed-free period and maximum weedy period may be shorter or longer depending on the weeds involved, which has clear practical implications.
- No significant yield loss was found when the crop remained weed-free during the first 36 days after transplanting.

Critical Period of Interference

Weeds	Tomato CPI	Pepper CPI
Amaranths (pigweeds)	2-4 WAT	2-4 WAT
Nightshades	2-7 WAT	1-3 WAT
Yellow nutsedge	2-10 WAT	1-7 WAT
Purple nutsedge	4-9 WAT	N/A
Dayflower	N/A	0-3 WAT

WAT = Weeks After Transplanting

Identification of weed species and their life cycles will have great impact on the selection and/or success of control measures.

Weeds are classified as grasses, broadleaf and sedges. They are further classified by the length of their life cycle (annual, biennial and perennial).

TRUE GRASS WEEDS have hollow, rounded stems and nodes (joints) that are closed and hard. The leaf blades have parallel veins, are much longer than they are wide and alternate on each side of the stem **(Figures 2 & 3)**. Some examples are crabgrass, goosegrass, crowfootgrass, sandbur, annual bluegrass, torpedograss and vaseygrass.

BROADLEAF WEEDS are a highly variable group of plants but most have showy flowers and net-like veins in their leaves. They are easy to separate from grasses due to their generally different leaf structure and habits of growth **(Figure 4)**. Some examples of broadleaf weeds are cudweed, creeping Charlie, eclipta, creeping beggarweed, cocklebur, sicklepod and Florida beggarweed.

SEDGES are an important group of "grass-like" weeds, but they are not true grasses. They are characterized by a solid, triangular-shaped stem with leaves extending in three directions and are usually referred to as nutgrass. There are two major perennial sedges that plague Florida vegetable growers: Yellow & Purple Nutsedge.

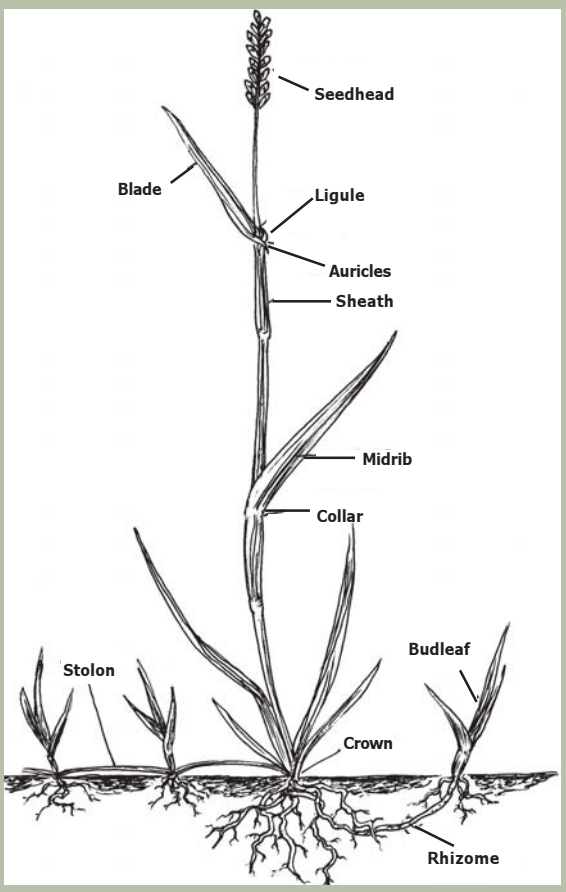

Figure 2. Anatomy of a grass.

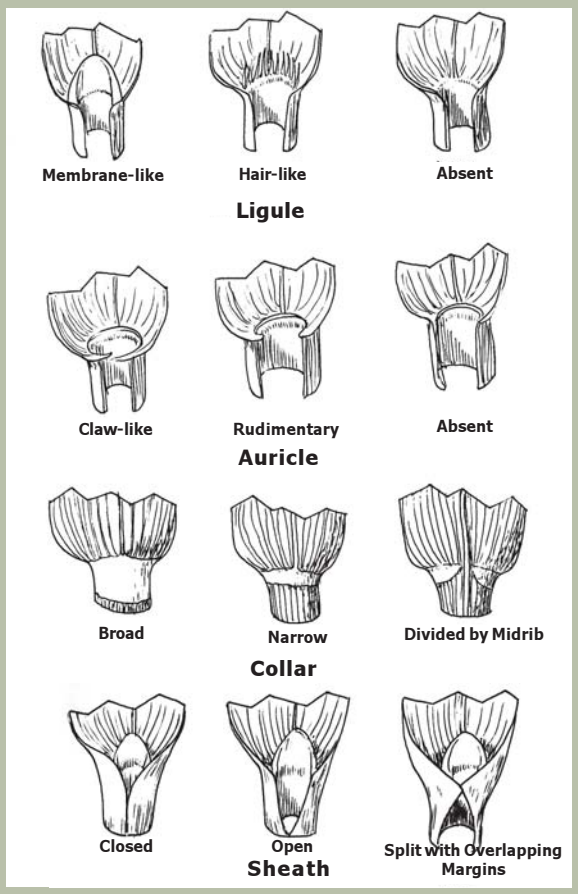

Figure 3. Ligule structures for grass identification.

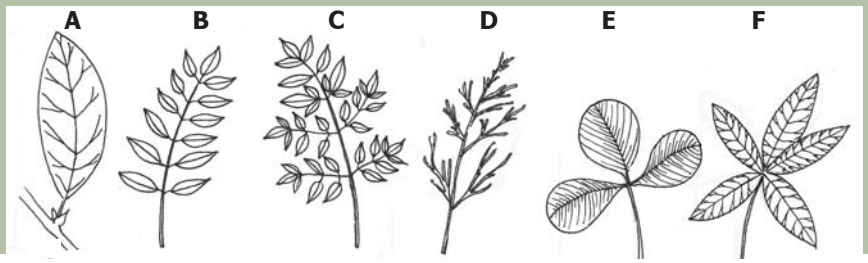

Figure 4. A=Simple leaf type; B - F = Compound leaf types: B=Pinnate; C=Bipinnate; D=Dissected; E=Trifoliate; F= Palmate.

Line drawings by: Jeff HansPetersen.

ANNUAL WEEDS complete their life cycle within one year. They germinate from seed, produce seed and die in 12 months or less. They may be annual grasses, sedges or broadleaf weeds. In addition, their life cycle may begin at different seasons of the year.

Figure 5. Row middles are quickly colonized by annual and perennial weeds. Photograph by: Phyllis Gilreath.

Summer annuals emerge in the spring and mature before winter. Weeds such as crabgrass and cocklebur are typical summer annuals.

Winter annual weeds sprout from seed in the fall and complete their life cycle before summer of the next calendar year. Wild radish, henbit, annual bluegrass and chickweed are examples of winter annual weeds.

BIENNIAL WEEDS have a 2-year life cycle. They germinate from seed in the fall; develop large root systems and a compact cluster of leaves during the first year, the second year they mature, produce seed and die. Examples of biennial weeds are cudweed, Carolina false dandelion, wild carrot and bull thistle.

PERENNIAL WEEDS live more than two years. They reproduce by vegetative parts such as tubers, bulbs, rhizomes (underground stems) or stolons (above-ground stems). Some also produce seed in addition to vegetative reproduction.

During the winter season, most survive in a dormant state, and many lose their above ground foliage and stems. With the beginning of spring, they regenerate from food reserves in their root systems **(Figure 5)**. Torpedograss, nutsedge and various vines are members of this group of weeds **(Figure 6)**.

Figure 6. Purple Nutsedge *Cyperus rotundus* is a perennial weed that reproduces mainly from tubers that develop along an underground rhizome. Photograph by: UF/IFAS.

WEEDS AS ALTERNATE HOSTS:

- Nightshade and volunteer tomatoes are hosts to various pests and diseases including whiteflies, nematodes, bacterial spot and viruses.
- Reducing populations of these pests can be accomplished with good weed control.
- Most growers concentrate on weed control in row middles; however, peripheral areas of the farm include: roadways, fallow fields, equipment parking areas, well and pump areas, fence rows and associated perimeter areas and ditches must be diligently managed.

Prepared by: Drs. Jason Ferrell & Bill Stall

Alligatorweed:
Alternanthera philoxerides

Photograph by: Kerry Dressler.

Description:

Alligatorweed is a perennial member of the pigweed family (Amaranthaceae). Reproduction occurs through seed and movement of stem fragments that readily root at the nodes. Alligatorweed is commonly found in wet or submersed habitats where the hollow stems allow floating mats to occur. However, alligatorweed commonly extends to dry ground, particularly when near irrigation ditches or seasonally wet areas. Leaves are oppositely arranged, have entire margins and possess a prominent midrib. Flowers are compact, white and solitary.

Key Feature:

Hollow stems and solitary white flowers.

Palmer Amaranth:
Amaranthus palmeri

Description:

Palmer amaranth is an erect summer annual that can reach 6 feet in height. Leaves are deeply veined, alternately arranged and possess petioles that are often longer than the leaf. Stems are hairless and often highly branched. Seedheads, like other *Amaranthus* species, are compact and originate from the terminals. However, Palmer amaranth seed heads commonly grow between 12 to 18 inches in length.

Key Feature:

Seedheads, panicles, that often grow to greater than 12 inches in length and petioles that are longer than the leaf.

Photograph by: Jason Ferrell.

Prepared by: Dr. Jason Ferrell

Spiny Amaranth:
Amaranthus spinosus

Photograph by: Jason Ferrell.

Description:

Spiny amaranth is an annual species most commonly found in highly, or repeatedly disturbed areas. Seedheads are compact and originate from the terminals. Leaves are deeply veined and alternately arranged. Stems are often red in color, hairless and possess hard, sharp spines. Spiny amaranth can grow to a height of 5 feet, but commonly grows to a height of 2 feet or less. Other common names include spiny pigweed or carelessweed.

Key Feature:

Deeply veined leaves and spined stem.

Bermudagrass:
Cynodon dactylon

Description:

Common bermudagrass is a low-growing perennial that reproduces from rhizomes, stolons (which root at the nodes) and seed. If left uncontrolled, the grass will form a thick turf with fine leaves. Leaf sheaths are sparsely hairy and do not contain auricles. Common bermudagrass is highly troublesome in managed crop fields since it responds vigorously to fertilize and irrigation. This species has poor tolerance to shading.

Key Feature:

This grass has scaly rhizomes and stolons that root at the nodes.

Photograph by: Jason Ferrell.

Smooth Crabgrass:
Digitaria ischaemum

Photograph from: Weeds of Southern Turfgrasses.

Description:

Crabgrass is a tufted or prostrate spreading summer annual. The leaves are smooth on both surfaces. The leaf sheath is smooth with a few long hairs at the collar. There are visible membranous ligules at base of the leaf blade. Crabgrass reproduces by seed and the seedhead has two to six "finger-like" branches. Smooth crabgrass is found throughout the United States.

Key Feature:

Smooth leaf with a few hairs at the collar.

Large Crabgrass:
Digitaria sanguinalis

Description:

Large crabgrass is a tufted, or prostrate to spreading summer annual with branched stems that root at the nodes. The leaf blade is longer than 2 inches (5 cm) and is usually hairy on both surfaces. There are visible toothed membranous ligules at the base of the leaf. The leaf sheath has dense hairs. There are spikelets in two to nine finger-like branches.

Key Feature:

Hairy leaf with blades longer than 2 inches.

Photograph by: Jason Ferrell.

Dodder:
Cuscuta spp.

Photograph by: Bill Stall.

Description:

Dodder is a parasitic annual with leafless, twining thread-like stems that tend to be orange in color. Dodder is parasitic and chiefly attaches to leguminous species, but will attach to most any actively growing plant. No, or very little, chlorophyll is produced by the plant and roots are only visible soon after seed germination. Dodder flowers in the fall and produces fruit, each containing four seeds.

Key Feature:

Leafless orange stems.

Prepared by: Dr. Jason Ferrell

Description:

Eclipta is an annual with prostrate to erect stems and rooting at the nodes. The rough and hairy leaves are opposite and narrow and have either smooth or toothed margins. Flowers are white and are arranged in long-stalked heads. Eclipta reproduces by seed and is found in moist disturbed areas. Eclipta occurs in Massachusetts, New York, Wisconsin, Iowa, Indiana, Illinois and Nebraska, south to Florida and west to Texas, Arizona, California and Hawaii.

Key Feature:

Rough hairy leaves with white flowers,

Eclipta:
Eclipta prostrata

Photograph from: Weeds of Southern Turfgrasses.

Florida Pusley:
Richardia scabra

Photograph from: Weeds of Southern Turfgrasses.

Description:

Florida pusley is a prostrate and spreading summer annual with branched hairy stems. Leaves are opposite, oval-shaped and somewhat thickened. The flowers are white and tubular, and are clustered at the ends of branches. Florida pusley is distinguished from Brazil pusley by presence of fruit with small bump-like projections and lack of thickened rootstock. This plant reproduces by seed. It is found in the southeast, northeast and midwestern United States.

Key Feature:

Hairy stems with broad, thick leaves.

Description:

Goosegrass is a tough, clumped summer annual, generally with a "whitish to silverish" coloration at the center of the plant. The leaf blade is smooth on both surfaces and occasionally has a few hairs near the base. There is a visible, short-toothed, membranous ligule at base of the leaf blade. Spikelets occur in two rows on two to thirteen fingers. Frequently there is a single finger below the terminal cluster of fingers. Goosegrass reproduces by seed. It is found throughout the temperate and warm parts of the United States.

Key Feature:

Clumped grass that is white or silver in the center.

Goosegrass:
Eleusine indica

Photograph from: Weeds of Southern Turfgrasses.

American Black Nightshade: *Solanum americanum*

Photograph by: Jason Ferrell.

Description:

American black nightshade is an annual, but often survives as a perennial in warm climates. It possesses a shallow taproot and a single stem that may become woody with age. Leaves are alternately arranged and may possess hairs, but frequently do not. Fruit are small round berries that are green when immature and black when ripe.

Key Feature:

Young leaves will not be purple on the underside as is common with eastern black nightshade.

Prepared by: Dr. Jason Ferrell

Purple Nutsedge: *Cyperus rotundus*

Description:

Purple nutsedge is a rapidly-spreading perennial with three-ranked basal leaves. Leaves are flat or slightly corrugated and are usually shorter than the flowering stem which abruptly tapers at the tip. The seedhead is purple to reddish brown, and is formed at end of a triangular stem. Tubers are oblong and are covered with hairs. They are found in chains connected by brown, wiry rhizomes. Tubers are bitter to taste. Purple nutsedge reproduces primarily by tubers.

Key Feature:

The seedhead is purple to reddish brown and is on the end of a triangular stem.

Photograph from: Weeds of Southern Turfgrasses

Yellow Nutsedge:
Cyperus esculentus

Photograph from: Weeds of Southern Turfgrasses.

Description:

Yellow nutsedge is a rapidly spreading perennial with three-ranked basal leaves. The leaves are flat or slightly corrugated and are usually as long as or longer than the flowering stem which has a long attenuated tip. The seedhead is yellowish-brown or straw colored and is formed at end of triangular stem. The tubers are round and are lacking hairs. They are formed at ends of whitish rhizomes which do not form chains of tubers. The tubers are slightly sweet to taste. Yellow nutsedge reproduces primarily by tubers. It is found throughout the United States.

Key Feature:

Yellow seedhead.

Description:

Annual with prostrate, ascending or erect, smooth stems. Leaves with long petioles. Leaf blades usually oval, sometimes slightly broader above the middle. Leaf tips, at least some, with a notch. Flowers green, in dense clusters in leaf axils or at tips of stems. Male and female flowers separate but mixed in the clusters. Reproduces by seed. Found in lawns, pastures, gardens and row crops.

Key Feature:

Green flowers in tight clusters at end of branch.

Livid Amaranth:
Amaranthus lividus

Photograph by: Bill Stall.

Common Purslane:
Portulaca oleracea

Photograph by: Bill Stall.

Description:

Purslane is a prostrate, succulent summer annual. Leaves alternate or are nearly opposite. They are fleshy, somewhat spoon-shaped. Stems are smooth and are usually purplish-red. Flowers are yellow, solitary in leaf axils or clustered on ends of stems. The fruit is a round capsule that splits open around the middle. This plant reproduces by seed and is found throughout the United States.

Key Feature:

Leaves spoon-shaped and stem is purplish-red.

Description:

Ragweed is a taprooted summer annual with branched stems. Leaves are hairy and are deeply twice dissected. Male and female flowers are green and separate. Ragweed reproduces by seed and is common in fields and pastures, on roadsides and in waste places. Ragweed is native to the US and occurs in the Northwest and Southeastern United States.

Key Feature:

Leaves are hairy and twice dissected.

Common Ragweed:
Ambrosia artemisiifolia

Photograph from: Weeds of Southern Turfgrasses.

Spreading Dayflower:
Commelina diffusa

Photograph from: Weeds of Southern Turfgrasses.

Description:

Dayflower is a freely-branched reclining annual with smooth stems. Leaves are broadly lance-shaped with closed sheaths. Sheaths are short with a few soft hairs on the upper margin. Flowers have three blue petals in a leaf-like structure which is open on the margins. Flowers are usually solitary. Spreading dayflower reproduces by seed and stem fragments and is found in most moist habitats. Occurs from Massachusetts, Missouri, Indiana, south into Florida and west to Texas, Kansas and Oklahoma.

Key Feature:

Solitary flowers with three blue petals.

Description:

Tall annual with erect, smooth to hairy stems. Petioles long. Leaf blades oval with a sharp tip. Male and female flowers mixed in clusters in leaf axils and in large terminal panicles. Reproduces by seed. Found in fields, moist areas, roadsides and disturbed areas.

Key Feature:

Small, green flowers enclosed by coarse, bristly spikes.

Smooth Pigweed:
Amaranthus hybridus

Photograph by: Bill Stall.

PREVENTION:

- Good prevention techniques can save growers money in weed control. Consider the ways weed seed enters the field and is distributed: wind, water, machinery*, in cover crop seed etc. Eliminate sources of weed seed **(Figure 7)**.
- The use of certified, registered, foundation seed or clean planting material cannot be overemphasized in preventing weeds from infesting fields.
- Fence rows and ditch banks are often neglected when controlling weeds in the crop. Seed produced in these areas may move into the field. Weeds in these areas can also harbor insects and diseases (especially viruses) that may move onto the crop.
- Clean equipment before entering fields or when moving from a field with a high weed infestation to a relatively clean field*.

*Nutsedge tubers especially are moved easily on discs, cultivators and other equipment.

Figure 7. An individual Palmer amaranth can produce between 200,000 to 600,000 seeds. Killing weeds before they go to seed is an important control strategy. Photograph by: Bill Stall.

CROP COMPETITION:

- An often overlooked tool in reducing weed competition is to establish a good crop stand, in which plants emerge and rapidly shade the ground.
- Plants that emerge first and grow the most rapidly are the plants that will have the competitive advantage.
- Utilization of good production management practices such as fertility, well-adapted varieties, proper water control (irrigation & drainage) and establishment of adequate plant population is very helpful in reducing weed competition.
- Everything possible should be done to insure that vegetables, not weeds, have the competitive advantage.

CROP ROTATION:

- If the same crop is planted in the same field year after year, there will be some weed or weeds favored by the cultural practices and herbicides used on that crop.
- By rotating to other crops, the cultural practices and herbicide program are changed. This often reduces the population of specific weeds which were tolerant in the previous cropping rotation.
- Care should be taken to not replant vegetables back into soil treated with a non-registered herbicide. Crop injury as well as vegetables containing illegal residues may result.
- Check the labels for plant-back limitations before application and planting rotational crops.

FALLOWING:

- Fallowing is a control method where the field is kept clean, i.e. free of cover crops and weeds during the time between crop seasons **(Figure 8)**. Fallowing can be accomplished by mechanical (disking or plowing), chemical (herbicides) or by a combination.
- Fallowing keeps any weeds that emerge during the off season from going to seed, it reduces the weed-seed bank in the soil and it will reduce any insects or nematodes that would survive on the weed hosts during the off season.

Figure 8. Field tillage and herbicide are being applied to maintain a fallow condition during the off season. Photograph by: Joe Noling.

MULCH:

- The use of polyethylene mulch increases yield and earliness of vegetables. The proper injection of fumigants under the mulch will control nematodes, soil insects, soil-borne diseases and weed seeds.
- Mulches act as a barrier to the growth of many weeds. Nutsedge can and will grow through most mulches. **More information about Mulches is available on pgs. 174-175**.

MECHANICAL CONTROL:

- Mechanical control practices are among the oldest of weed management techniques and include field preparation by plowing or disking, cultivation, mowing, hoeing and hand pulling of weeds. It is a primary reason for preparing land for crops planted in rows.
- Seedbed preparation by plowing or disking exposes many weed seeds to variations in light, temperature and moisture. For some weeds, this process breaks weed-seed dormancy, leading to early season control with herbicides or additional cultivation.
- Cultivate only deep enough in the row to achieve weed control. Deep cultivation may prune crop roots, bring weed seeds to the surface and disturb the soil previously treated with an herbicide.
- When seeds can be controlled without cultivation, there is no advantage to cultivating. There may be disadvantages such as drying out the soil surface, bringing weed seeds to the surface and disturbing the root system of the crop.
- The burial of active growing points of annual weeds is an effective method of control. Burial is usually less effective on perennial weeds which have underground stems and roots and are capable of re-growth from these underground storage organs.
- Mowing is usually most effective on tall growing annuals and not as effective on short growing plants, perennials or grasses. The growth habit of the plant usually indicates how effective mowing will be. Annual weeds are usually mowed to prevent seed production and to allow the crop a better competitive advantage.

Prepared by: Dr. Bill Stall

CHEMICAL SELECTION:

- Properly selected herbicides are effective tools for weed control. Herbicides may be classified several ways, depending on how they are applied and their mode of action in or on the plant.
- Generally herbicides are either soil applied or foliage applied.
- Herbicides may be selective or non-selective, and they may be either contact or translocated through the plant. For example, paraquat is a foliage applied, contact, non-selective herbicide, while atrazine usually is described as a soil-applied, translocated, selective herbicide.
- Correctly identifying problem weed species is essential for selecting the correct control methods and herbicide. Contact your county extension agent for assistance with identification.

Figure 9. Aim damage from drift due to improper application of the herbicide. Photograph by: Bill Stall.

See **Appendix 4** for a table listing herbicides registered for use in tomato and pepper in Florida and their effectiveness on select weeds.

DEFINITIONS:

Fumigants are pesticides or mixtures of pesticides which produce vapors (gases) that fill an area (i.e. soil) and kill the pest. Fumigants can be applied as solids, liquids or gasses. The degree of control depends on the pesticide or mixture and the rate, plus the time the gas is in the soil.

Contact herbicides kill only those parts of the plant which the spray touches, i.e. paraquat.

Translocated/systemic herbicides are taken into the plant and moved throughout the plant tissues, i.e. glyphosate (Roundup®) or sethoxydim (Poast®).

Foliage applied herbicides may be applied to leaves, stems and shoots of plants. They require good coverage and the addition of either a specified surfactant or specific formulation for best control.

Soil-applied herbicides that are applied to the surface and not incorporated require moisture shortly after application for best results.

Incorporated herbicides are not dependent on rainfall or irrigation and have generally given more consistent and wider-spectrum control. Soil incorporated herbicides improve the contact of the herbicide with the weed seed and/or minimize the loss of the herbicide by volatilization or photo degradation. They do, however, require more time and equipment.

IMPLEMENTING WEED CONTROL:

- Identifying weed problems and selecting multiple appropriate control methods are essential steps in designing or modifying a weed control program.
- Generally, for pre-plant and pre-emergence applications, the weed problem must be anticipated since weeds have not emerged at the time of application. This can be done by observing the field in the previous season and recording (mapping) those weeds which are present and in what areas of the field they occur.
- Weed maps can be very useful the next season in refreshing your memory and making decisions on which herbicides to purchase.
- Crop rotation is an excellent way to reduce weed shifts due to specific herbicide use **(Figure 10)**. Be aware of plant-back restrictions on herbicides used the previous crop.
- Once weed problems have been determined, the tables on **pg. 203** can be helpful in determining the herbicides which is most effective for control of those weeds.

Figure 10. Watermelon is commonly used as a crop rotation in the form of double cropping. Photograph by: Phyllis Gilreath.

CONTACT INFORMATION:

Dr. William M. Stall
UF/IFAS Horticultural Sciences Dept.
P.O. Box 110690
Gainesville, FL 32611
wms@ifas.ufl.edu
352-392-1928 ext. 207

References:

Stall, W.M. 2006. Chapter 15. Weed Management. *In* Ed. S.M. Olson and E. Simonne. Vegetable Production Handbook for Florida 2006-2007, UF IFAS Extension.

Ferrell, J.A., G.E. MacDonald and J. Tredaway Ducar. 2005. Principles of Weed Management. UF IFAS EDIS publication SS-AGR-100, http://edis.ifas.ufl.edu/WG041.

Murphy, T.R., D.L. Colin, R. Dickens, J.W. Everest, D. Hall and L.B. McCarty. 1992. Weeds of Southern Turfgrass. University of Georgia Press, http://commodities.caes.uga.edu/turfgrass/georgiaturf/WeedMngt/index.html.