

USING PLASTIC MULCHES AND DRIP IRRIGATION FOR VEGETABLE PRODUCTION

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Muskmelons, tomatoes, peppers, cucumbers, squash, eggplant, watermelons and okra are vegetable crops that have shown significant increases in earliness, yield, and fruit quality when grown on plastic mulch. Some less-valuable crops such as sweet corn, snap beans, southern peas and pumpkins have shown similar responses. Some of the advantages and disadvantages of using plastic mulches are outlined below. (For additional information, see Bulletin AG-489, *Plasticulture for Commercial Vegetables*.)

Advantages

1. **Increased soil temperature** – At a 2-inch depth; 4 to 5 °F under black mulch or 8 to 10 °F under clear mulch.
2. **Reduced soil compaction** – Soil under plastic mulch remains loose, friable, and well-aerated. Roots have access to adequate oxygen, and microbial activity is excellent.
3. **Reduced fertilizer leaching** – Water runs off the impervious mulch, resulting in maximum utilization of the fertilizer.
4. **Reduced drowning of crops** – Water is shed from the row area, and excess water runs off the field, thus reducing drowning and other excess soil-water stresses.
5. **Reduced evaporation** – Soil water does not escape from under plastic mulch.

Plant growth on mulch is often at least twice that on bare soil. The resulting larger plants will require more water, so mulching is not a substitute for irrigation.

6. **Cleaner product** – A mulched crop is cleaner and less subject to rots due to the elimination of soil splashing on the plants or fruits. Note: Beds should be firm and tapered away from the row center. Plastic should be tight to promote run-off. *There should be no puddles on the mulched beds!*
7. **Root pruning eliminated** – Cultivation is not necessary, except for the area between the mulched strips. Therefore, roots are not pruned.
8. **Reduced weed problems** – Black plastic mulch provides good weed control in the row. Clear plastic will require the use of a herbicide or of fumigation. Often, weeds between mulch strips can be controlled by a herbicide.
9. **Earlier crops** – Black plastic mulch can result in a 2- to 14-day earlier harvest, while clear plastic can result in a 21-day earlier harvest.
10. **Increased growth** – Plastic mulch is practically impervious to carbon dioxide, (CO₂), a gas that is of prime

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importance in photosynthesis. Very high levels of CO₂ build up under the plastic, because the film does not allow it to escape. It has to come through the holes made in the plastic for the plants, and a “chimney effect” is created, resulting in localized concentrations of abundant CO₂ for the actively growing leaves.

Disadvantages

1. **Costly to remove** – Plastic mulch and drip irrigation tube must be removed from the field annually. Black plastic does not break down and should never be disked into the soil. Clear plastic does break down with time but leaves a messy field. Photo- and bio-degradable plastics hold promise.
2. **Greater initial costs** – Plastic mulch and drip irrigation will increase cost of production. These costs should be offset by increased income due to earlier harvests, better quality fruit, and higher yields.
3. **Increased management** – Plastic mulch and drip irrigation must be monitored carefully on a daily basis to be successful.
4. **Increased soil erosion** – Soil erosion increases in “middles” between the plastic strips.
5. **Increased crop/weed competition** – Weeds can grow out of the holes in close proximity to crops.

Preparation of the Soil – The first step is to take two soil samples in early fall. Have one sample assayed for mineral content and one for nematodes. If the soil test suggests applying lime, apply enough in the fall to reach pH 6.0 to 6.5 using dolomitic lime, if magnesium is low. If a nematode problem exists, fumigate the soil at the time the plastic mulch is being laid. By using a multipurpose fumigant (e.g., Terr-O-Gas 67, Vapam, Vorlex), you can get good control of weeds, nematodes and soil-borne diseases. The soil should be free of debris and in good physical condition before the beds are prepared for fumigation.

Fertilization – Using the soil test report as a guide, apply fertilizer during bed preparation. Consult Horticultural Information Leaflets for specific crop recommendations. Amounts to be sidedressed need to be included in the total

fertilizer requirements. **Caution:** Using fertilizers with ammoniacal N in fumigated soils can result in ammonium toxicity to the crop. Normally, at least 50% of the nitrogen (N) should be in nitrate (NO₃) form.

When using drip irrigation with plastic mulch, one half of the N and K, and all of the P, should be incorporated at bedding. The remaining N and K should be applied through the drip tube using soluble fertilizers (e.g. calcium nitrate, sodium nitrate, 20-20-20, 15-0-14, or potassium nitrate). Overhead irrigation and fertigation can be used by perforating the plastic. The entire amount of fertilizer may be incorporated in the bed, but utilization by plants might be less efficient than with fertigation.

Bedding the Soil – Bedding machines available to growers include Kennco Manufacturing, Inc. and Riddick Equipment Co. single- and multiple-row models. With some bedding machines, the soil is lifted and then bedded in one operation (superbedders). With others, the soil is first lifted in one operation with hilling disks or double-disk hillers on a tool bar and then compressed to a uniform height and density using a bed press pan. **Note:** Be sure that enough soil is pulled up so that the bed has good, sharp corners. Bedded rows should be spaced on 5- or 6-foot centers, depending on the equipment. A bed with a 30-inch top should slope from the center to the edge with a drop of 1.25 inches, allowing excess rainfall to run off the mulch.

Fall vs. Spring – Laying the plastic mulch and drip tube plus fumigating in the fall has several advantages:

1. Wet weather conditions are prevalent in the spring and can result in delays in laying the plastic and in transplanting.
2. Better soil fumigation is possible in the fall, because the soil is not apt to be too wet or too cold.
3. Nematode populations should be the highest in the fall, and maximum eradication is possible at that time.
4. Fall-applied mulch often makes it possible to transplant 10 to 14 days earlier in the spring.

Fumigating and Laying the Plastic Mulch and Drip Tube – The amount of fumigant actually applied per acre will depend on row width and will be a percentage of the broadcast rate (Consult the current *N.C. Agricultural Chemicals Manual*). Air temperature should be at least 50 °F, and the soil should be well worked, free of undecomposed plant debris, and have adequate moisture

for seed germination. If both the air and soil are warm, most fumigants should escape through the plastic mulch within 12 to 14 days.

The plastic mulch is generally 4 or 5 feet wide, 1.25 to 1.50 mil thick, *embossed* (diamond-shaped design on film which helps hold mulch tight against the soil) or *slick*, and comes in 2,400-ft. rolls.

For single-row crops such as tomatoes, cucumbers, muskmelons, honeydews, watermelons, and pumpkins, the drip tube should be placed 4 to 5 inches from the center of the bed and 1 to 2 inches deep, with the emitters facing upward. Each roll has between 1,000 to 7,500 feet of drip tube, depending on the brand. For double-row crops, such as summer squash, okra, eggplant, peppers, beans, peas, lettuce, and sweet corn, the drip tube should be placed directly on the center of the bed and buried 2 to 3 inches deep. Five-ft row centers have 8,712 linear feet of row per acre, so a grower would need about 3.5 rolls of plastic mulch per acre. For 6-foot centers, 3 rolls of plastic mulch will be needed per acre. **Note:** Take time to adjust the machine so that the press wheels hold the plastic firmly against the bed and the disks place soil halfway up the side of the bed but not on top of the bed. Also, anchor the plastic and drip tube when starting applications, covering it with soil and standing on the drip tube.

Pest Management

Weed Control – For information on weed control under clear plastic mulch and in the row middles between black plastic mulch, consult Horticultural Information Leaflet No. 33-D, the *N.C. Agricultural Chemicals Manual*, or your county Extension center. Only approved herbicides can be used between rows of plastic, because this is not a fallow area.

Insect and Disease Control – Good insect and disease control is essential. Consult the current *N.C. Agricultural Chemicals Manual* or your county Extension center for recommendations.

Transplanting – For extra earliness in peppers and tomatoes, large containers (cell sizes 3 to 4 inches) should be used. For the other vegetable crops, use 1- to 2-inch cell sizes. Consult Bulletin AG-337, *N.C. Commercial*

Transplants for details on transplant production. Transplants can be set by hand or machine (e.g. Kennco plant-setter, waterwheel, or pot transplanters). When transplanting by hand, several tools can be used to make holes in the plastic, such as a long-handled bulb setter or a sturdy can or cylinder welded onto the end of a handle. The hole should be 2 to 4 inches wide and deep enough for the plants to be transplanted. A hand tobacco plant setter works well once the holes are made in the plastic mulch. With both hand setting and machine setting, the use of a “starter solution,” a soluble fertilizer high in phosphorous (P) will often get the plants off to a good start. Examples are 12-52-12, 10-20-10, or 12-48-8.

Irrigation – Drip irrigation is recommended for use with plastic mulches, although other types can be used successfully. The frequency of irrigation will depend on soil type and stage of crop growth. Irrimeters at the 6-inch and 12-inch depth in the mulched bed are recommended as an aid in determining irrigation needs. Frequent probing with a soil tube near the plant row will also help to keep a check on soil moisture. Normally, the area around the drip tube is very soft to the touch, and the side of the row away from the tube should be only slightly soft. For more detailed information on trickle/drip irrigation consult Horticultural Information Leaflets Nos. 33-A and 33-B; *The Irrigation Handbook*, Dept. of Biological and Agricultural Engineering; *Trickle Irrigation in the Eastern United States* prepared by Northeast Regional Agricultural Engineering Service, Cornell University, Ithaca, NY 14853; an irrigation specialist; or your county Extension center office. **DO NOT USE PLASTIC MULCH WITHOUT IRRIGATION.**

Double Cropping the Plastic Mulch – Once the first crop has been harvested, it is recommended that a second crop be grown on the mulch. This “intensive cropping” results in two acres of production from each acre of actual land. The second crop can be fertilized (1) through the drip line using soluble fertilizers and a fertilizer injector, (2) through overhead fertigation, or (3) by placing fertilizer in holes in the plastic between plants. Consult Horticultural Information Leaflet No. 33-C for additional information on injecting fertilizers through the drip line.

Never plant a field to the same crop twice in one year. Suggested spring-fall sequences are listed below:

Spring	Fall
• Peppers	• Summer squash, cucumbers or cole crops
• Tomatoes	• Cucumbers, summer squash or cole crops
• Summer squash	• Tomatoes or cole crops
• Eggplant	• Summer squash
• Cucumbers	• Tomatoes
• Muskmelons	• Tomatoes
• Watermelons	• Tomatoes
• Honeydews	• Tomatoes
• Cole crops	• Summer squash, pumpkins, muskmelons, tomatoes
• Cauliflower	• Summer squash, pumpkins, muskmelons, tomatoes
• Snap beans	• Summer squash, pumpkins, muskmelons, tomatoes
• Southern peas	• Summer squash, pumpkins, muskmelons, tomatoes
• Lettuce	• Summer squash, pumpkins, muskmelons, tomatoes
• Sweet corn	• Summer squash, tomatoes, or cucumbers
• Strawberries	• Tomatoes, summer squash, cucumbers, pumpkins

Glyphosate (Roundup® and various other trade names) can be used to terminate the first crop. See Horticulture Information Leaflet No. 33-D. **Note:** Take care to avoid damaging the trickle/drip tube when planting the second crop.

Windbreaks – Strips of rye should be established to protect vegetable seedlings from prevailing winds. Each rye strip should be the width of a typical grain drill (8 to 10 feet) and far enough apart to plant 5 or 6 rows of vegetable seedlings. Well-grown rye strips planted in the fall will promote earliness and provide protection for the young transplants. Spring topdressing in February will help assure a good, thick rye stand.

When laying plastic in the spring, plant the entire field with rye, but be sure to work up the crop area early enough in the spring to minimize crop debris interference with fumigating and plastic laying. Once wind protection is no longer required, mow the rye and use this area as a drive row for spraying and harvesting. Use this drive row for a

boom sprayer that covers 2.5 or 3 rows on either side of the drive. An airblast sprayer can also be used.

Reflective Plastic Mulches – The reflective properties of aluminum-faced plastic have been shown to interfere with the movement of aphids which spread the watermelon mosaic virus II. This virus causes the green streaking in the fall yellow squash. By using this mulch, a grower would be able to harvest marketable squash for a longer period of time in the fall. Painting the plastic with aluminum paint or white paint increases its reflectivity and cools late planted crops resulting in better fruit quality.

Infrared-Transmitting (IT) Mulch – IT mulch is a recent development. These plastics transmit the warming wavelengths of the sun but not those that allow weeds to grow. These materials result in warmer soils than black plastic but cooler soils than clear plastics. The IT mulches retard the growth of weeds, including nutsedge. Crops grown on IT mulch will develop 7 to 10 days earlier than crops grown on black plastic.

Some Yield Increases – Plastic mulch systems can produce significant yield increases, if managed properly.

Examples of Yield Increases from Using Plastic Mulch Systems

Crop	Average yield per acre with plastic and drip	Increase over state average
Eastern cantaloupe	6,000 fruits	4X
Western cantaloupe	15,000 fruits	5X
Cucumbers	1,200 bu	5X
Pepper	1,200 bu	4X
Squash	800 bu	4X
Tomato	2,500 boxes	3X
Watermelon	3,000 fruits	4X

Final Comments – In addition to the machines you can purchase for laying plastic mulch and drip tube and for fumigating the soil, custom applicators are also available. With proper planning, good management, *attention to details* and dedication to all aspects of the cropping sequence, earlier and higher yields are possible using the “intensive” cultural methods described in this publication.