INTRODUCTION

This guide for organic production of pickling cucumbers and butternut squash provides an outline of cultural and pest management practices and includes topics that have an impact on improving plant health and reducing pest problems. It is divided into sections, but the interrelated quality of organic cropping systems makes each section relevant to the others.

The guide attempts to compile the most current information available, but acknowledges that effective means of control are not available for some pests. More research on growing crops organically is needed, especially in the area of pest management. Future revisions will incorporate new information, providing organic growers with a complete set of useful practices to help them achieve success.

This guide uses the term Integrated Pest Management (IPM), which like organic production, emphasizes cultural, biological, and mechanical practices to minimize pest outbreaks. With limited pest control products available for use in many organic production systems, an integrated approach to pest management is essential. IPM techniques such as identifying and assessing pest populations, keeping accurate pest history records, selecting the proper site, and preventing pest outbreaks through use of crop rotation, resistant varieties and biological controls are important to producing a high quality crop.

1. GENERAL ORGANIC MANAGEMENT PRACTICES

1.1 Organic Certification

To use a certified organic label, farming operations that gross more than $5,000 per year in organic products must be certified by a U.S. Department of Agriculture National Organic Program (NOP) accredited certifying agency. The choice of certifier may be dictated by the processor or by the target market. A list of accredited certifiers (Link 7) operating in New York can be found on the New York State Department of Agriculture and Markets Organic Farming Development/Assistance(Link 8). See more certification and regulatory details under Section 4.1 *Certification Requirements* and Section 10: *Using Organic Pesticides.*

1.2 Organic Farm Plan

An organic farm plan is central to the certification process. The farm plan describes production, handling, and record-keeping systems, and demonstrates to certifiers an understanding of organic practices for a specific crop. The process of developing the plan can be very valuable in terms of anticipating potential issues and challenges, and fosters thinking of the farm as a whole system. Soil, nutrient, pest, and weed management are all interrelated on organic farms and must be managed in concert for success. Certifying organizations may be able to provide a template for the farm plan. The following description of the farm plan is from the NOP web site:

The Organic Food Production Act of 1990 (OFPA or Act) requires that all crop, wild crop, livestock, and handling operations requiring certification submit an organic system plan to their certifying agent and, where applicable, the State Organic Program (SOP). The organic system plan is a detailed description of how an operation will achieve, document, and sustain compliance with all applicable provisions in the OFPA and these regulations. The certifying agent must concur that the proposed organic system plan fulfills the requirements of subpart C, and any subsequent modification of the organic plan by the producer or handler must receive the approval of the certifying agent.

More details may be found at: the Agricultural Marketing Service's National Organic Program website (Link 9). The National Sustainable Agriculture Information Service, (formerly ATTRA), has produced a guide to organic certification that includes templates for developing an organic farm plan (Link 10). The Rodale Institute has also developed resources for transitioning to organic and developing an organic farm plan (Link 11).

2. SOIL HEALTH

Healthy soil is the basis of organic farming. Regular additions of organic matter in the form of cover crops, compost, or manure create a soil that is biologically active, with good structure and capacity to hold nutrients and water (note that any raw manure applications should occur at least 120 days before harvest). Decomposing plant materials will activate a diverse pool of microbes, including those that break down organic matter into plant-available nutrients as well as others that compete with plant pathogens on the root surface.

Rotating between crop families can help prevent the buildup of diseases that overwinter in the soil. Rotation with a grain crop, preferably a sod that will be in place for one or more seasons, deprives disease-causing organisms of a host, and also contributes to a healthy soil structure that promotes vigorous plant growth. The same practices are effective for preventing the buildup of root damaging nematodes in the soil, but keep in mind that certain grain crops are also hosts for some nematode species. Rotating between crops with late and early season planting dates can help prevent the buildup of weed populations. Organic growers must attend to the connection between soil, nutrients, pests, and weeds to succeed. An excellent resource for additional information on soils and soil health is Building Soils for Better Crops, 3rd edition, by Fred Magdoff and Harold

Van Es, 2010, available from SARE, Sustainable Agriculture Research and Education, www.sare.org/publications/soils.htm (Link 16). For more information, refer to the Cornell Soil Health website (Link 17).

3. COVER CROPS

Unlike cash crops, which are grown for immediate economic benefit, cover crops are grown for their valuable effect on soil properties and on subsequent cash crops. Cover crops help maintain soil organic matter, improve soil tilth, prevent erosion and assist in nutrient management. They can also contribute to weed management, increase water infiltration, maintain populations of beneficial fungi, and may help control insects, diseases and nematodes. To be effective, cover crops should be treated as any other valuable crop on the farm, carefully considering their cultural requirements, life span, mowing recommendations, incorporation methods, and susceptibility, tolerance, or antagonism to root pathogens and other pests. Some cover crops and cash crops share susceptibility to certain pathogens and nematodes. Careful planning and monitoring is required when choosing a cover crop sequence to avoid increasing pest problems in subsequent cash crops. See Tables 3.1 and 3.2 for more information on specific cover crops and Section 8: *Crop and Soil Nutrient Management* for more information about how cover crops fit into a nutrient management plan.

A certified organic farmer is required to plant certified organic cover crop seed. If, after contacting at least three suppliers, organic seed is not available, then the certifier may allow conventional seed to be used. Suppliers should provide a purity test for cover crop seed. Always inspect the seed for contamination with weed seeds and return if it is not clean. Cover crop seed is a common route for introduction of new weed species onto farms.

3.1 Goals and Timing for Cover Crops

Adding cover crops regularly to the crop rotation plan can result in increased yields of the subsequent cash crop. Goals should be established for choosing a cover crop; for example, to add nitrogen, smother weeds, or break a pest cycle. The cover crop might best achieve some of these goals if it is in place for the entire growing season. If this is impractical, a compromise might be to grow the cover crop between summer cash crops. Allow two or more weeks between cover crop incorporation and cash crop seeding to permit decomposition of the cover crop, which will improve the seedbed and help avoid any unwanted allelopathic effects on the next cash crop. Another option is to overlap the cover crop and the cash crop life cycles by overseeding, interseeding or intercropping the cover crop between cash crop rows at final cultivation. An excellent resource for determining the best cover crop for your situation is Northeast Cover Crop Handbook, by Marianne Sarrantonio (Reference 21) or the Cornell online decision tool to match goals, season, and cover crop (Link 15).

Leaving cover crop residue to remain on the soil surface might make it easier to fit into a crop rotation and will help to conserve soil moisture, but some of the nitrogen contained in the residue will be lost to the atmosphere, and total organic matter added to the soil will be reduced. Turning under the cover crop will speed up the decomposition and nitrogen release from the crop residue.

3.2 Legume Cover Crops

Legumes are the best cover crop for increasing available soil nitrogen. Legumes have symbiotic bacteria called rhizobia, which live in their roots and convert atmospheric nitrogen gas in the soil pores to ammonium, a form of nitrogen that plant roots can use. When the cover crop is mowed, winter killed or incorporated into the soil, the nitrogen is released and available for the next crop. Because most of this nitrogen was taken from the air, there is a net nitrogen gain to the soil (See Table 3.1). Assume approximately 50 percent of the fixed nitrogen will be available for the crop to use in the first season, but this may vary depending on the maturity of the legume, environmental conditions during decomposition, the type of legume grown, and soil type..

It is common to inoculate legume seed with rhizobia prior to planting, but the inoculant must be approved for use in organic systems. Request written verification of organic approval from the supplier and confirm this with your organic farm certifier prior to inoculating seed.

Interseeding Red Clover into Cucurbits

Red clover may be interseeded into vining type winter squash at a rate of 10-15 lbs/acre at last cultivation, just before the plants start to run. The seed may be spun on while cultivating, or in a separate pass immediately after. The clover will germinate and establish under the plant canopy and continue to grow after frost kills the vines. Left to grow for the next season, it can provide enough nitrogen to meet the requirement for heavy nitrogen feeders the following season. Alternately, the clover can be cut for hay, but this will result in less nitrogen returned to the soil.

3.3 Non-Legume Cover Crops

Barley, rye grain, rye grass, Sudangrass, wheat, oats, and other grain crops left on the surface or plowed under as green manures or dry residue in the spring are beneficial because they capture nitrogen that otherwise might be leached from the soils. If incorporated, allow two weeks or more for decomposition prior to planting to avoid the negative impact on stand establishment from actively decomposing material. Three weeks might not be enough if soils are very cold. In wet years, the presence of cover crop residues may increase slug damage.

3.4 Biofumigant Cover Crops

Certain cover crops have been shown to inhibit weeds, pathogens, and nematodes by releasing toxic volatile chemicals when tilled into the soil as green manures and degraded by microbes or when cells are broken down by finely chopping. Degradation is quickest when soil is warm and moist. These biofumigant cover crops include Sudangrass, sorghum-sudangrasses, and many in the brassica family. Varieties of mustard and arugula developed with high glucosinolate levels that maximize biofumigant activity have been commercialized (e.g. Caliente brands 199 and Nemat).

Attend to the cultural requirements of the cover crops to maximize growth. Fertilizer applied to the cover crops will be taken up and then returned to the soil for use by the cash crop after the cover crop is incorporated. Biofumigant cover crops like mustard should be allowed to grow to their full size, normally several weeks after flowering starts, but incorporated before the seeds become brown and hard indicating they are mature. To minimize loss of biofumigant, finely chop the tissue early in the day when temperatures are low. Incorporate immediately by tilling, preferably with a second tractor following the chopper. Lightly seal the soil surface using a culti-packer and/or 1/2 inch of irrigation or rain water to help trap the volatiles and prolong their persistence in the soil. Wait at least two weeks before planting a subsequent crop to reduce the potential for the breakdown products to harm the crop, also known as phytotoxicity. Scratching the soil surface before planting will release remaining biofumigant. This biofumigant effect is not predictable or consistent. The levels of the active compounds and suppressiveness can vary by season, cover crop variety, maturity at incorporation, amount of biomass, fineness of chopping, how quickly the tissue is incorporated, soil microbial diversity, soil tilth, and microbe population density.

Cover Crops for Vegetable Growers: Decision Tool (Link 15).

Northeast Cover Crops Handbook (Reference 21).

Cover Crops for Vegetable Production in the Northeast (Reference 23).

Crop Rotation on Organic Farms: A Planning Manual (Link 18).

Table 3.1 Leguminous Cover Crops: Cultural Requirements, Nitrogen Contributions and Benefits.

Species	Planting Dates	Life Cycle	Cold Hardiness Zone	Tolerances: Heat	Tolerances: Drought	Tolerances: Shade	pH Preference	Soil Type Preference	Seeding (lb/A)	Nitrogen Fixed (lb/A)a	Comments
CLOVERS											
Alsike	April-May	Biennial/ Perennial	4	5	5	6	6.3	Clay to silt	4-10	60-119	+Endures waterlogged soils & greater pH range than most clovers
Berseem	Early spring	Summer annual/ Winter annual[b]	7	6-7	7-8	5	6.5-7.5	Loam to silt	9-25	50-95	+Good full-season annual cover crop
Crimson	Spring	Summer annual/ Winter annual[b]	6	5	3	7	5.0-7.0	Most if well-drained	9-40	70-130	+Quick cover +Good choice for overseeding (shade tolerant) + Sometimes hardy to zone 5.
Red	Very early spring or late summer	Short-lived perennial	4	4	4	6	6.2-7.0	Loam to clay	7-18	100-110	+Strong taproot, good heavy soil conditioner +Good choice for overseeding (shade tolerant)
White	Very early spring or late summer	Long-lived perennial	4	6	7	8	6.2-7.0	Loam to clay	6-14	≤130	+Good low maintenance living cover +Low growing +Hardy under wide range of conditions
SWEET CLOVERS											

Table 3.1 Leguminous Cover Crops: Cultural Requirements, Nitrogen Contributions and Benefits.

Species	Planting Dates	Life Cycle	Cold Hardiness Zone	Heat (Tolerances)	Drought (Tolerances)	Shade (Tolerances)	pH Preference	Soil Type Preference	Seeding (lb/A)	Nitrogen Fixed (lb/A)a	Comments
Annual White	Very early spring	Summer annual[b]	NFT	6-7	6-7	6	6.5-7.2	Most	15-30	70-90	+Good warm weather smother & catch crop +Rapid grower +High biomass producer
Biennial White and Yellow	Early spring-late summer	Biennial	4	6	7-8	4	6.5-7.5	Most	9-20	90-170	+Deep taproot breaks up compacted soils & recycles nutrients +Good catch crop +High biomass producer
Other Legumes											
Cowpeas	Late spring-late summer	Summer annual[b]	NFT	9	8	6	5.5-6.5	Sandy loam to loam	25-120	130	+Rapid hot weather growth
Fava Beans	April-May or July-August	Summer annual[b]	8	3	4	NI	5.5-7.3	Loam to silty clay	80-170 small seed 70-300 lg seed	71-220	+Strong taproot, good conditioner for compacted soils + Excellent cover & producer in cold soils +Efficient N-fixer
Hairy Vetch	Late August-early Sept.	Summer annual/ Winter annual	4	3	7	5	6.0-7.0	Most	20-40	80-250 (110 ave.)	+Prolific, viney growth +Most cold tolerant of available winter annual legumes
Field Peas	March-April OR late summer	Winter annual/ Summer annual[b]	7	3	5	4	6.5-7.5	Clay loam	70-220	172-190	+Rapid growth in chilly weather

NI=No Information, NFT=No Frost Tolerance. Drought, Heat, Shade Tolerance Ratings: 1-2=low, 3-5=moderate, 6-8=high, 9-10=very high. [a] Nitrogen fixed but not total available nitrogen. See Section 8 for more information. [b] Winter killed.
Reprinted with permission from Rodale Institute®, http://www.rodaleinstitute.org/ , M. Sarrantonio. 1994. Northeast Cover Crop Handbook. (Reference 21).

Table 3.2 Non-leguminous Cover Crops: Cultural Requirements and Crop Benefits

Species	Planting Dates	Life Cycle	Cold Hardiness Zone	Heat (--Tolerances--)	Drought (--Tolerances--)	Shade (--Tolerances--)	pH Preference	Soil Type Preference	Seeding (lb/A)	Comments
Brassicas e.g. mustards, rapeseed	April or late August-early Sept.	Annual / Biennial [b]	6-8	4	6	NI	5.3-6.8	Loam to clay	5-12	+Good dual purpose cover & forage +Establishes quickly in cool weather +Biofumigant properties
Buckwheat	Late spring-summer	Summer annual [b]	NFT	7-8	4	6	5.0-7.0	Most	35-134	+Rapid grower (warm season) +Good catch or smother crop +Good short-term soil improver for poor soils
Cereal Rye	August-early October	Winter annual	3	6	8	7	5.0-7.0	Sandy to clay	60-200	+Most cold-tolerant cover crop +Excellent allelopathic weed control

Table 3.2 Non-leguminous Cover Crops: Cultural Requirements and Crop Benefits										
SPECIES	PLANTING DATES	LIFE CYCLE	COLD HARDINESS ZONE	HEAT	DROUGHT	SHADE	PH PREFERENCE	SOIL TYPE PREFERENCE	SEEDING (LB/A)	COMMENTS
				--TOLERANCES--						
								loams		+Good catch crop +Rapid germination & growth +Temporary N tie-up when turned under
Fine Fescues	Mid March-mid-May OR late Aug.-late Sept.	Long-lived perennial	4	3-5	7-9	7-8	5.3-7.5 (red) 5.0-6.0 (hard)	Most	16-100	+Very good low-maintenance permanent cover, especially in infertile, acid, droughty &/or shady sites
Oats	Mid-Sept-early October	Summer annual[b]	8	4	4	4	5.0-6.5	Silt & clay loams	110	+Rapid growth +Ideal quick cover and nurse crop
Ryegrasses	August-early Sept.	Winter annual (AR)/ Short-lived perennial (PR)	6 (AR) 4 (PR)	4	3	7 (AR) 5 (PR)	6.0-7.0	Most	14-35	+Temporary N tie-up when turned under +Rapid growth +Good catch crop +Heavy N & moisture users
Sorghum-Sudangrass	Late spring-summer	Summer Annual[b]	NFT	9	8	NI	Near neutral	NI	10-36	+Tremendous biomass producers in hot weather +Good catch or smother crop +Biofumigant properties

NI-No Information, NFT-No Frost Tolerance. Drought, Heat, Shade Tolerance Ratings: 1-2=low, 3-5=moderate, 6-8=high, 9-10=very high. AR=Annual Rye, PR=Perennial Rye. [b]Winter killed.

Reprinted with permission from Rodale Institute®, http://www.rodaleinstitute.org/, M. Sarrantonio. 1994. Northeast Cover Crop Handbook. (Reference 21).

4. FIELD SELECTION

For organic production, give priority to fields with excellent soil tilth, high organic matter, good drainage and airflow.

4.1 Certifying Requirements

Certifying agencies have requirements that affect field selection. Fields cannot be treated with prohibited products for three years prior to the harvest of a certified organic crop. Adequate buffer zones are required between certified organic and conventionally grown crops. Buffer zones must be a barrier, such as a diversion ditch or dense hedgerow, or be a distance large enough to prevent drift of prohibited materials onto certified organic fields. Determining what buffer zone is needed will vary depending on equipment used on adjacent non-certified land. For example, use of high-pressure spray equipment or aerial pesticide applications in adjacent fields will increase the buffer zone size. Pollen from genetically engineered crops can also be a contaminant. An organic crop should not be grown near a genetically engineered crop of the same species. Check with your certifier for specific buffer requirements. These buffers commonly range between 20 to 250 feet depending on adjacent field practices.

4.2 Crop Rotation Plan

A careful crop rotation plan is the cornerstone of organic crop production because it allows the grower to improve soil quality and proactively manage pests. Although growing a wide range of crops complicates the crop rotation planning process, it ensures diversity in crop residues in the soil, and a greater variety of beneficial soil organisms. Individual organic farms vary widely in the crops grown and their ultimate goals, but some general rules apply to all organic farms regarding crop rotation. Rotating individual fields away from crops within the same family is critical and can help minimize crop-specific disease and non-mobile insect pests that persist in the soil or overwinter in the field or field borders. Pests that are persistent in the soil, have a wide host range, or are wind-borne, will be difficult to control through crop rotation. Conversely, the more host specific, non-mobile, and short-lived a pest is, the greater the ability to control it through crop rotation. The amount of time required for a crop rotation is based on the particular pest and its severity. Some particularly difficult pests may require a period of fallow. See specific recommendations in the disease and insect sections of this guide (Sections 11, 12, 13). Partitioning the farm into management units will help to organize crop rotations and ensure that all parts of the farm have sufficient breaks from each type of crop.

A well-planned crop rotation is key to weed management. Short season crops such as lettuce and spinach are harvested before many weeds go to seed, whereas vining cucurbits, with their limited cultivation time and long growing season, allow weeds to go to seed before harvest. Including short season crops in the rotation will help to reduce weed populations provided the field is cleaned up promptly after harvest. Other weed reducing rotation strategies include growing mulched crops, competitive cash crops, short-lived cover crops, or crops that can be intensively cultivated. Individual weed species emerge and mature at different times of the year, therefore alternating between spring, summer, and fall planted crops helps to interrupt weed life cycles.

Cash and cover crop sequences should also take into account the nutrient needs of different crops and the response of weeds to high nutrient levels. High soil phosphorus and potassium levels can exacerbate problem weed species. A cropping sequence that alternates crops with high and low nutrient requirements can help keep nutrients in balance. The crop with low nutrient requirements can help use up nutrients from a previous heavy feeder. A fall planting of a non-legume cover crop will help hold nitrogen not used by the previous crop. This nitrogen is then released when the cover crop is incorporated in the spring. See Section 5: *Weed Management,* and Section 3: *Cover Crops* for more specifics.

Rotating crops that produce abundant organic matter, such as hay crop and grain-legume cover crops, with ones that produce less, such as vegetables, will help to sustain organic matter levels and promote good soil tilth (see Section 2: *Soil Health* and Section 8: *Crop and Soil Nutrient Management*). Cucurbits generally have a medium nutrient requirement (Table 4.2.1). Growing a cover crop, preferably one that includes a legume (unless the field has a history of *Pythium* problems), prior to or after a cucurbit crop, will help to renew soil nutrients, improve soil structure, and diversify soil organisms. Deep-rooted crops in the rotation to help break up compacted soil layers.

Table 4.2.1 Crops Nutrient Requirements

	Nutrient Needs		
	Lower	**Medium**	**Higher**
Crop	bean beet carrot herbs pea radish	cucumber eggplant brassica greens pepper pumpkin spinach chard squash winter squash	broccoli cabbage cauliflower corn lettuce potato tomato

From NRAES publication *Crop Rotation on Organic Farms: A Planning Manual*. Charles L. Mohler and Sue Ellen Johnson, editors, (Link 18).

Crop Information Specific to Cucurbits

Plan at least three years between cucurbit family plantings and peppers, eggplants, tomatoes or other cucurbits. Crucifers would be an especially good crop to precede cucurbits.

Table 4.2.2 Potential Interactions of Crops Grown in Rotation with Cucurbits

Crops in Rotation	Potential Rotation Effects	Comments
Many crops	*Decrease* weeds	**Mulched** vine crops help reduce weed populations for subsequent crops. Mulched cucurbits are a good choice prior to growing crops where weed control is challenging.
Carrot, lettuce, spinach and other direct seeded crops.	*Increase* weeds in direct seeded crops	**Unmulched** vine crops are often very weedy. Do not follow with direct seeded crops such as carrot, parsnip, lettuce, or spinach.
Eggplant, pepper	*Increase Phytophthora capsici*	*Phytophthora capsici* causes collar rot of eggplant and Phytophthora blight in cucurbits and peppers. Use a rotation of more than 3 years between these crops. Also found on weeds: common purslane, eastern black nightshade, horsenettle, velvetleaf, field pepperweed, field pennycress, Virginia pepperweed.
Broccoli, cauliflower, Brussels sprouts, kale, cabbage, collards, radish, rutabaga, turnip, daikon	*Decrease* clubroot	Clubroot declines more quickly when grown in rotation with cucurbits, tomato, snap bean or buckwheat.

Table 4.2.2 Potential Interactions of Crops Grown in Rotation with Cucurbits

Crops in Rotation	Potential Rotation Effects	Comments
Corn	*Increase* corn rootworm	Corn rootworm adults are attracted to cucurbits. They lay their eggs at the base of the plants and the larvae attack corn roots the following year.
Lettuce, spinach, brassica greens	Possible double cropping	Cucurbits can be double cropped when planted after early salad crops or brassica greens.
Hairy vetch	Early seeding of cover crop	Hairy vetch can be overseeded into winter squash in July to provide a winter cover crop after harvest.

Excerpt from Appendix 2 of Crop Rotation on Organic Farms: A Planning Manual. Charles L. Mohler and Sue Ellen Johnson, editors. (Link 18)

4.3 Pest History

Knowledge about the pest history for each field to plan a successful cropping strategy. Germination may be reduced in fields with a history of *Pythium* or *Rhizoctonia*. Avoid fields that contain heavy infestations of perennial weeds such as nutsedge, bindweed, and quackgrass as these weeds are particularly difficult to control. One or more years focusing on weed population reduction using cultivated fallow and cover cropping may be needed before organic crops can be successfully grown in those fields. Susceptible crops should not be grown in fields with a history of *Sclerotinia* white mold without a rotation of several years to sweet corn or grain crops. Treat with Contans WG™ to reduce fungal sclerotia in the soil immediately after an infected crop is harvested.

All cultivated cucurbits are hosts for both root-knot nematode, *Meloidogyne hapla*, and root-lesion nematode, *Pratylenchus penetrans*. It is important to know whether or not these nematodes are present in the field in order to develop long-term crop rotations and cropping sequences that either reduce the populations in heavily infested fields or minimize their increase in fields that have no to low infestation levels. Refer to Section 12 for more information on nematodes.

4.4 Soil and Air Drainage

Cucurbits need well drained soil types to reduce the risk of *Phytophthora blight*.

With the exception of powdery mildew, most fungal and bacterial pathogens need free water on the plant tissue or high humidity for several hours in order to infect. Any practice that promotes leaf drying or drainage of excess water from the root zone will minimize favorable conditions for infection and disease development. Fields with poor air movement, such as those surrounded by hedgerows or woods, result in leaves staying wet. Plant rows parallel to the prevailing winds, which is typically in an east-west direction, and avoid overcrowding to promote drying of the soil and reduce moisture in the plant canopy.

5. Weed Management

Weed management can be one of the biggest challenges on organic farms, especially during the transition and the first several years of organic production. To be successful, use an integrated approach to weed management that includes crop rotation, cover cropping, cultivation, and planting design, based on an understanding of the biology and ecology of dominant weed species. A multi-year approach that includes strategies for controlling problem weed species in a sequence of crops will generally be more successful than attempting to manage each year's weeds as they appear. Relying on cultivation alone to manage weeds in an organic system is a recipe for disaster.

Management plans should focus on the most challenging and potentially yield-limiting weed species in each field. Be sure, however, to emphasize options that do not increase other species that are present. Alternating between early and late-planted crops, and short and long season crops in the rotation can help minimize buildup of a particular weed or group of weeds with similar life cycles or growth habits, and will also provide windows for a variety of cover crops.

5.1 Record Keeping

Scout and develop a written inventory of weed species and their severity for each field. Accurate identification of weeds is essential. Weed fact sheets provide a good color reference for common weed identification. See Penn State University *Weed Identification* book (Reference 20), or Cornell weed ecology and Rutgers weed gallery websites (Links 29-30).

5.2 Weed Management Methods

Planting and cultivation equipment should be set up on the same number of rows to minimize crop losses and damage to crop roots during cultivation. It may be necessary to purchase specialized equipment to successfully control weeds in some crops. See resources at the end of this section to help fine-tune your weed management system.

Weeds in cucurbits are difficult to control after the crop vines out in the row, because tractor cultivation becomes impossible. A high percentage of weeds will then go to seed and carry over the weed problem to the following year. Transplanting cucurbits rather than direct seeding allows the canopy to close quicker and can reduce in-row weed development.

Planting cucurbits into black plastic mulch is another strategy to improve weed control, since the mulch prevents weed germination in the area immediately near the crop. Cultivate the aisles between plastic covered beds with sweeps. To avoid weed problems along the edges of the plastic, either use vegetable knives to under cut the margin of the plastic or use hilling discs or spider gangs to throw additional soil onto the edge of the plastic to bury weeds. These cultivations will be most effective when weeds are small.

Straw mulch is an alternative to black plastic, but will cool the soil and slow crop development. Straw can also be used for weed suppression between plastic covered beds. Rodents may nest in the straw, however, and then feed on the fruit. Also, belly rot may be more prevalent in straw mulch. If using straw without plastic, tine weed and cultivate direct seeded crops as indicated below, then lay straw shortly before vines run out. For effective weed control lay 3 inches of baled compressed material or 6 inches of loose straw, which can be blown through a hydro-seeding cannon or bale chopper.

If direct seeding without black plastic, tine weed just before emergence and again 5 to 7 days after emergence. A third tine weeding may be possible a week later. Set the weeder to work about 2/3 of the seeding depth. When tine weeding cucurbits, avoid using weeders with > 45 degree bends in the tines.

Alternatively, cucurbits can be direct seeded or transplanted in a grid pattern, with equal spacing in and between rows. This allows cultivation in both directions. See Section 7: Planting Methods for spacing recommendations. In either case, cultivate at 10 to 14-day intervals for as long as possible. Once winter squash is well established, throw soil around the base of the plants to bury small weeds. Hand hoe before the vines run out of the row. Do the last cultivation with vegetable knives pointed *toward* the crop, which will allow you to reach in under the leaves and cultivate later and closer to the row.

Butternut squash is reasonably tolerant of weed competition.

Resources

Steel in the Field by Greg Bowman: http://www.sare.org/publications/steel/index.htm (Link 28).
Cornell Weed Ecology website: http://weedecology.css.cornell.edu/ (Link 29).
Rutgers University, New Jersey Weed Gallery: http://njaes.rutgers.edu/weeds/ (Link 30).
University of Vermont videos on cultivation and cover cropping: http://www.uvm.edu/vtvegandberry/Videos/videos.html (Link 31).
ATTRA Principles of Sustainable Weed Management for Croplands: http://attra.ncat.org/attra-pub/weed.html (Link 32).
New Cultivation Tools for Mechanical Weed Control in Vegetables http://www.vegetables.cornell.edu/weeds/newcultivationmech.pdf (Link 33)

6. Recommended Varieties

Variety selection is important both for the horticultural characteristics specified by the processor and the pest resistance profile that will be the foundation of a pest management program. If disease pressures are known, tables 6.1 and 6.2 can help to determine which varieties will be more successful in reducing disease problems. Collaborate with processors on varieties, choosing those with some level of disease resistance if possible.

A certified organic farmer is required to plant certified organic seed. If, after contacting at least three suppliers, organic seed is not available for a particular variety, then the certifier may allow untreated conventional seed to be used.

Table 6.1 Disease Resistance of Pickling Cucumber Varieties for Processing

	Angular Leaf Spot	Anthracnose	Bacterial Wilt	Downy Mildew	Powdery Mildew	Scab	Cucumber Mosaic Virus	Papaya Ringspot Virus	Watermelon Mosaic Virus	Zucchini Yellow Mosaic Virus
Alibi				X	X					
Amour					X					
Ballerina					X	X	X			

Table 6.1 Disease Resistance of Pickling Cucumber Varieties for Processing

	Angular Leaf Spot	Anthracnose	Bacterial Wilt	Downy Mildew	Powdery Mildew	Scab	Cucumber Mosaic Virus	Papaya Ringspot Virus	Watermelon Mosaic Virus	Zucchini Yellow Mosaic Virus
Bush Pickle						X	X			
Calypso F1	X	X		X	X	X	X			
Carolina F1	X	X		X	X	X	X	X	X	
Classy	H				X					
Cross Country	X	X		X	X	X	X			
County Fair	X		X							
Earlipik 14						M	M			
Eclipse	X	X		X	X	X	X			
Eureka	H	H		H	H	H	H	X	X	X
Fancy Pak M	X	X		X	X	X	X			
Fiesty					X					
FM 5020					X					
Jackson Classic F1	X	X		X	X	X	X			
Jackson Supreme	X	X		M	X	X	X			
H-19 Little Leaf					X					
Lafayette Classic F1	X	X		X	X	X	X			
Moxie					X					
Napoleon classic F1	X	X		X	X	X	X			
Patton					X					
Pioneer	X	X		X	X		X			
Salty				X	X	X	X			
Sassy	X	X		H	X	X	X	X		
SMR58					X	X				
Spear It					X					
Spunky					X					
Timor					X					
Vlasstar F1	X	X		X	X	X	X			
Wellingon F1	X	X		X			X			
Wisconsin SMR						X				
Zapata	X	X		H	X	X	X	X	X	X

L-low resistance, M-medium resistance, H-high resistance X- variety has some level of resistance based on seed catalog information.

Table 6.2 Powdery Mildew Resistance in Butternut-type Winter Squash Varieties

Variety	Relative Maturity	Plant Type	Fruit Color	Fruit Size	Disease Resistance
Achieve	90 days	Large Bush	Lt Tan	4-6 lbs	PMR
Argonaut	140 days	Vigorous Vine	Orange	30 lbs	None
Atlas	90 days	Short Vine	Lt Tan	10-12"	None
Avalon	88 days	Vigorous Vine	Buff	5"x11"	None
Betternut 401	80 days	Semi-Bush	Lt Tan	8-9"; 3 lb	PMR
Bugle	80 days	Semi-Bush	Lt Tan	10"	PMR
Butternut Supreme	80 days	Semi-Bush	Lt Tan	10-12"	None

Table 6.2 Powdery Mildew Resistance in Butternut-type Winter Squash Varieties

Variety	Relative Maturity	Plant Type	Fruit Color	Fruit Size	Disease Resistance
Casius	110 days	Vine	Lt Tan	14-15"	None
Early Butternut	85 days	Semi-Bush	Tan	8"	None
JWS 6823	100 day	Vine	Orange	3-4 lbs	PMR
Metro	105 days	Vine	Orange	2.5-3.5 lbs	PMR
Matilda	110 days	Vine	Lt Tan	7-9 lbs	None
Neck Pumpkin	120 days	Vine	Lt Brown	18-24"	None
Pilgrim	80 days	Semi-Bush	Lt Tan	8-10"	None
Provider	100 day	Large Bush	Lt Tan	6-12 lbs	PMR
Ultra	90 days	Vine	Lt Tan	15"	None
Waltham	97 days	Vine	Lt Tan	10-12"	Plectosporium

PMR = Powdery Mildew Resistance

Table 6.3 Ranking of Butternut Varieties by Cucumber Beetle Preference

Variety	Ranking
Zenith	13
Butternut Supreme	16
Early Butternut	25
Waltham	28

Ranking 1-14- non-preferred, > 45 – highly preferred.

7. PLANTING METHODS

7.1 Cucumber

Direct seeded cucumbers are planted May 25th to July 15th. Wait 2 to 3 weeks depending on soil temperature and moisture between plowing down a cover crop and planting direct seeded cucurbits so that the cover crop has sufficient time to decompose to avoid allelopathy and seedcorn maggot.

If a processing grower wanted to experiment with transplants, in upstate New York, they are typically set in the field between June 1st and 10th for harvest in mid-August to early September. Using transplants requires careful timing to avoid allowing the plants to become root-bound in the transplant flats.

Wind, combined with low air temperatures (32° to 50°F), can severely damage vine crops, retarding maturity and reducing yields. Soil temperatures below 50°F also slow growth and impair water uptake by roots. For these reasons, plastic mulch and row covers are often used. Black, clear, or infrared-transmitting (IRT) mulches can be used.

Another means of wind protection is to plant rye strips between every second or third row of the crop. Site selection is also important for wind protection and optimal soil temperature. Light-textured soils that warm quickly in the spring are preferable to heavier soils that remain cool. Good drainage, fertility, and high organic matter are other soil features that will improve the potential for good yield and quality.

7.2 Winter squash

These are normally direct seeded after all danger of frost is past, between May 25th and June 15th. Winter squash also can be planted on a grid, with equal distance in and between rows, to allow cultivation both ways.

Table 7.1 Recommended spacing

Crop	Row	In-row
Cucumber-Pickles	2-5′	3-8″
Squash-Butternut	6-8′	24-48″

8. CROP & SOIL NUTRIENT MANAGEMENT

To produce a healthy crop, soluble nutrients must be available from the soil in amounts that meet the minimum requirements for the whole plant. The total nutrient needs of a crop are much higher than just the nutrients that are removed from the field when that crop is harvested. All of the roots, stems, leaves and other plant parts require nutrients at specific times during plant growth and development. The challenge in organic systems is balancing soil fertility to supply these required plant nutrients at a time, and at sufficient levels, to support healthy plant growth. Restrictions in any one of the needed nutrients will slow growth and can reduce crop quality and yields.

Organic growers often speak of feeding the soil rather than feeding the plant. A more accurate statement is that organic growers focus their fertility program on feeding soil microorganisms rather than the plant. Soil microbes decompose organic matter to release nutrients and convert organic matter to more stable forms such as humus. This breakdown of soil organic matter occurs throughout the growing season, depending on soil temperatures, water availability and soil quality. The released nutrients are then held on soil particles or humus making them available to crops or cover crops for plant growth. Amending soils with compost, cover crops, or crop residues also provides a food source for soil microorganisms and when turned into the soil, starts the nutrient cycle again.

During the transition years and the early years of organic production, soil amendment with composts or animal manure can be a productive strategy for building organic matter, biological activity and soil nutrient levels. This practice of heavy compost or manure use is not, however, sustainable in the long-term. If composts and manures are applied in the amounts required to meet the nitrogen needs of the crop, phosphorous may be added at higher levels than required by most vegetable crops. This excess phosphorous will gradually build up to excessive levels, increasing risks of water pollution or invigorating weeds like purslane and pigweed. A more sustainable, long-term approach is to rely more on legume cover crops to supply most of the nitrogen needed by the crop and use grain or grass cover crops to capture excess nitrogen released from organic matter at the end of the season to minimize nitrogen losses to leaching (See Section 3: *Cover Crops*). When these cover crops are incorporated into the soil, their nitrogen, as well as carbon, feeds soil microorganisms, supporting the nutrient cycle. Harvesting alfalfa hay from the field for several years can reduce high phosphorus and potassium levels.

The primary challenge in organic systems is synchronizing nutrient release from organic sources, particularly nitrogen, with the crop requirements. In cool soils, microorganisms are less active, and nutrient release may be too slow to meet the crop needs. Once the soil warms, nutrient release may exceed crop needs. In a long-term organic nutrient management approach, most of the required crop nutrients would be in place as organic matter before the growing season starts. Nutrients required by the crop in the early season can be supplemented by highly soluble organic amendments such as poultry manure composts or organically approved bagged fertilizer products (see Tables 8.2.4 to 8.2.6). These products can be expensive, so are most efficiently used if banded at planting. The National Organic Program rules that no more than 20% of nitrogen can be applied as Chilean nitrate. Confirm the practice with your organic certifier prior to field application.

Regular soil testing helps monitor nutrient levels, in particular phosphorus (P) and potassium (K). Choose a reputable soil-testing lab (Table 8.0.1) and use it consistently to avoid discrepancies caused by different soil extraction methods.

Maintaining a soil pH between 6.3 and 6.8 will maximize the availability of all nutrients to plants.

Table 8.0.1 Nutrient Testing Laboratories

Testing Laboratory	Soil	Compost/ Manure	Forage	Link
Cornell Soil Health Lab	x			19
Agri Analysis, Inc.		x		20
A&L Eastern Ag Laboratories, Inc.	x	x		21
Penn State Ag Analytical Services Lab	x	x		22
The Dairy One Lab			x	23
University of Massachusetts	x	x		24

Develop a plan for estimating the amount of nutrients that will be released from soil organic matter, cover crops, compost, and manure. A strategy for doing this is outlined in Section 8.2: *Preparing an Organic Nutrient Budget.*

8.1 Fertility

Recommendations from the Cornell Integrated Crop and Pest Management Guidelines (Link 1) indicate a cucurbit crop requires 100 lb. of available nitrogen (N), 120 lb. of phosphorus (P), and 120 lb of potassium (K) per acre. These levels are based on the total needs of the whole plant and assume the use of synthetic fertilizers. Farmer and research experience suggests that lower levels may be adequate in organic systems. See Table 8.2.2 for the recommended rates of P and K based on soil test results. Nitrogen is not included because levels of available N change in response to soil temperature and moisture, N mineralization potential, and leaching. . As many of the nutrients as possible should come from cover crop, manure, and compost additions in previous seasons.

If the crop is grown with plastic mulch, the nitrogen level can be reduced to 70 lb. of available N. The more uniform moisture and warmer temperatures under plastic mulch increase the decomposition rate of soil organic matter, which increases available N.

The source of these nutrients depends on soil type and historic soil management. Some soils are naturally high in P and K, or have a history of manure applications that have resulted in elevated levels. Additional plant available nutrients are supplied by decomposed soil organic matter or through specific soluble nutrient amendments applied during the growing season in organically managed systems. Many types of organic fertilizers are available to supplement the nutrients supplied by the soil. **ALWAYS check with your certifier before using any product to be sure it is approved**.