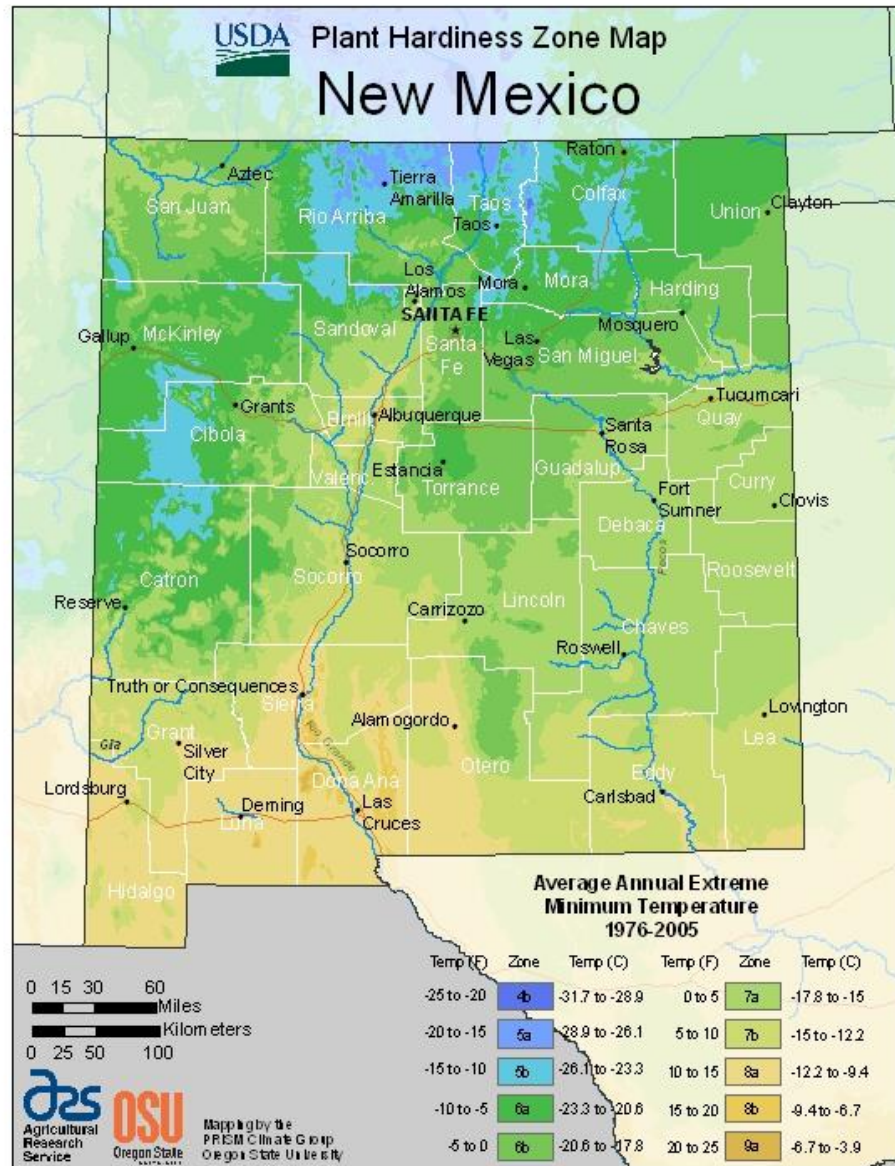


Growing Vegetables: Timing & Companion Planting

Dr. Stephanie J. Walker
Extension Vegetable
Specialist





<http://planthardiness.ars.usda.gov/PHZMWeb/>

NM Number of Frost Free Days

- New Mexico is a large, diverse state
- Area 1: more than 180 days (Las Cruces, Lordsburg)
- Area 2: less than 180, more than 150 days (Albuquerque, Santa Fe, Roswell)
- Area 3: less than 150 days (Farmington, Gallup)

Growing Vegetables – Timing

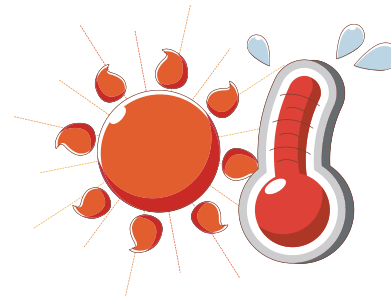
- Temperature
- Light
- Pest, disease, weed pressure
- Environmental stress (example: wind, moisture)
- Know your vegetables
- Planning & recordkeeping

Timing

- Timing; use succession planting and intercropping for continuous planting and harvest
- Set up 'infrastructure' to prolong growing season, depending on the needs of the vegetable

Constraints - Temperature

- Many vegetables expire at cold temps; some suffer at high temps
- Plant vegetables for growth during their preferred temperature
- Warm Season vs. Cool Season Vegetables



Warm vs. Cool Season Crops

- Warm season crops:
 - Squash, tomatoes, eggplant, okra, cucumber, beans, chile, bell peppers
- Cool season crops:
 - Broccoli, carrots, spinach, lettuce, chard, peas, kale, onions, beets, radishes

Temperature

- In general, warm season vegetables prefer temperatures in the 75 – 85 F range; cool season vegetables prefer temperatures in the 65 – 75 F range

Temperature

- Warm season vegetables will be injured or killed by frost
- Cool season vegetable tolerate (or are improved) by frost, but growth slows at very low temperatures

Light

- Vegetables grown for their 'fruit' (tomatoes, peppers, melons, squash) require at least 8 hours of sunlight per day for healthy growth
- Even in temperature controlled greenhouses - limited sunlight during winter months slow or prevent fruit set
- Leafy greens require approx. 6 hours



Timing

KNOW YOUR VEGETABLES

Selecting the Vegetable and Cultivar

- Know your vegetables
- Determinate vs. indeterminate
- Days to maturity
- Tomatoes
 - 'Early Girl' 52 days
 - 'Better Boy' 75 days
 - 'Zapotec' 80 days

Spacing

- Know the size potential of every plant in order to give it enough space
- Example: Carrots need approximately 4 in. between plants, broccoli needs about 1 foot between plants



Harvest at the Right Time

Know your vegetables



-Premature harvest reduces amount of nutrient and flavor compounds



-Late harvest may result in a fibrous, less tender, bland or bitter crop

Manure

- Improves nutrient content of the soil
- Compost manure to kill undesirable microbes, weed seed
- Be wary of salt content
- Be wary of herbicides ingested by the animals



Pests

- Pests are any animal or plant that interfere with optimum growing conditions for your crop
- Disease, insects, weeds
 - Many harmful insect pests are attracted to weeds
 - Insects can transfer disease across large areas



Pest / Disease Interactions

- Example: Curly top virus
- Only spread by Beet Leafhoppers
- Large number of winter weeds result in higher leafhopper population



Beet leafhopper
[Picture by J. Appleby]



Preventing Pest Problems

- Scout
 - At least twice a week
 - Good to get down to plant level
- Beneficials
 - Insects that help keep pest insect populations down
 - Attract with flowers and habitat



Weeds

- “Plants growing where you don’t want them to grow”
- Don’t allow weeds to go to seed!
- Control by:
 - Mechanical removal
 - Mulch
 - Herbicides
 - Targeted water application



Mulching

- Pros
 - Keeps weeds at bay
 - Conserves soil moisture
 - Keeps fruit off ground
- Cons
 - Could harbor pests
 - Increases soil temp
 - Labor and cost investment



http://thailand.ipminfo.org/images/components/Organic_farm_egg_plant_mulching_3.JPG

Mulch

- How to apply
 - Once plants are established, cover ground 2 – 4 inches
 - Water to help settle
 - Don't cover plants (will lead to etiolation)
- Types
 - Straw, leaves, wood chips, newspaper, plastic, pecan shells, compost

SEEDS & TRANSPLANTS

Know Your Plants

- **Hybrid vs. open-pollinated seed**

Hybrid: The first-generation seed obtained from crossing two different inbred lines/plants under controlled conditions

-Seed is often expensive

Open-pollinated: Seed produced through field pollination

Know Your Plants

- **Hybrids:** Produce plants 'improved' compared to either parent
- **Open-pollinated:** Produce plants like the parent
- All heirloom plants are open-pollinated, but not all open-pollinated plants are heirlooms

Plant Your Garden

- **Direct seeding** is the easiest way to plant your garden
- **Transplants** are used to obtain earlier maturity, or if seed is expensive
 - May be harder to purchase in Fall



Transplants

- When to start
 - 4 - 6 weeks before first frost free day
 - Start in clean potting soil or peat pots
 - Start by warm, sunny window
- Sterilize soil
 - Prevents damping off
 - Oven or pressure cooker (160°F), or use commercial potting mix



HARDEN off your seedlings

- About one week before transplanting:
 - Put your seedlings outside in a shady place
 - protected from wind - for approx. 2-4 hours
 - Then bring them back inside
 - Each day increase the time
 - Slowly begin dividing the time between the shade and the sun
 - After a week of adjustment the seedlings should be ready for the garden plot

Perennial Vegetable Crops

- Asparagus
 - Productive for 10 to 15 years
- Artichokes
- Rhubarb
- Take extra care in placement



Matthew Wallenstein 2004

Asparagus (*Asparagus officinalis*)

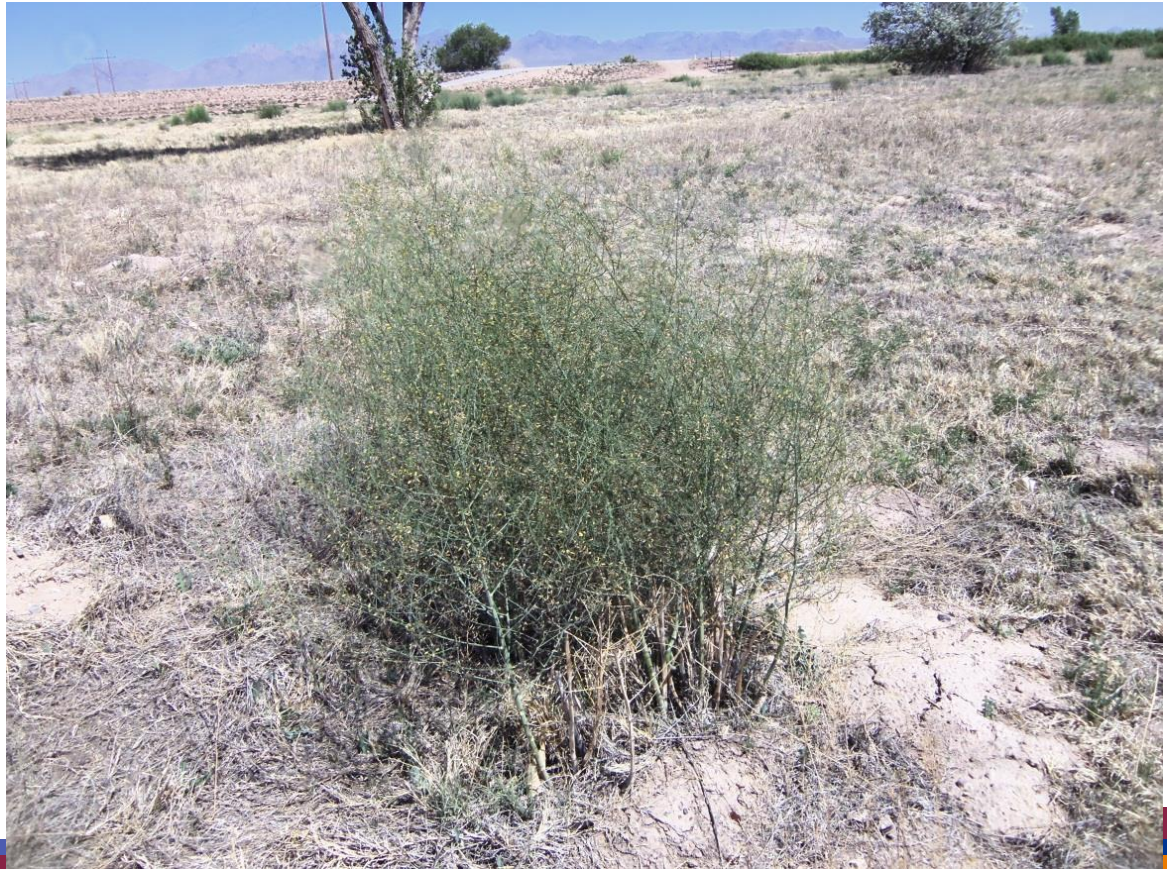
- Family Asparagaceae
- Tolerant of heat, drought and salinity
- Perennial; productive for many years
- Dioecious - male and female plants
- Modern varieties all male, so more spear production





Asparagus

- Wild asparagus near the Rio Grande



Asparagus Culture

- Start from crowns
 - 12-18 inches apart
- Don't harvest 1st year
- Stop harvesting
 - spears are less than diameter of a pencil
- Allow ferns to develop to feed the plants
- Fertilize ferns with N
 - remove during winter to top dress with manure



Asparagus Varieties

- Open-pollinated varieties:
‘Mary Washington’
‘Martha Washington’
- Hybrid, all-male varieties:
‘Jersey Giant’
‘Jersey Knight’
‘Purple Passion’



<http://garden.lovetoknow.com/wiki/images/Garden/3/31/Asparagus.JPG>



Know Your Plants

- **Determinate:** Bush-type. Tend to set fruit at same time and exhibit earlier maturity
- **Indeterminate:** Vining, pole-type. Tend to set fruit over prolonged period and have higher overall yields



Warm vs. Cool Season Crops

- Warm season crops (Summer) include:
 - Squash, tomatoes, eggplant, okra, cucumber, beans, chile, bell peppers
- Cool season crops (Spring & Fall) include:
 - Broccoli, carrots, spinach, lettuce, chard, kale, onions, beets, radishes

Warm Season Vegetables: Family Ties

Grass Family (*Poaceae*): Corn

Nightshade Family (*Solanaceous*): Tomatoes, Eggplant, Peppers, Potatoes

Bean Family (*Leguminosae*): Green Beans, Kidney Beans, Pinto Beans

Cucurbit Family (*Cucurbitaceae*): Cucumbers, Squash, Melons

Sweet Corn (*Zea mays*)

- Annual; member of grass family
- Plant sequentially every two weeks to prolong harvest
- Harvest when silks are brown and dry, and kernels are in milk stage

Sweet Corn

- Wind pollinated
 - poor pollination causes skips on cob
 - Plant in short, side-by-side rows
- Pollen source affects kernel quality



http://www.webgardenguide.com/admin/_files/newsannounce/Sweet_corn.jpg

Sweet Corn Cultivars

- ‘Merit’
- ‘Early Sunglow’
- ‘Hybrid Double Delicious’
- ‘Early Xtra-Sweet’
- ‘How Sweet It Is’



Solanaceous Crops

- Tomatoes, bell peppers, chile, eggplant, potatoes
- Grown as annuals



Tomatoes

- Most popular vegetable for home gardens
- Direct seed or transplant
- Self fertile, wind-pollinated flowers



“Trenching-in” long stemmed plants



Use a sturdy stake about 1-1½ inches in diameter and 6 feet long.

Tie plants using twine or strip of cloth.

Train to 2 main stems leading 1 up each side of stake.



Pruning and Staking

- Indeterminate cultivars
- Leave two main stems
- Remove suckers between leaves and main stem
- Remove suckers before they get 2 ½ inches long
- Remove late season flower buds

CURLY TOP OF TOMATO



Photos Courtesy of Dr. Ron Walser

Beet Curly Top Virus – Management Strategies

- Weed removal
- Insecticides
(not very effective)
- Kaolin Clay
- Shading
- Leafhopper
exclusion



Disorders: Blossom End Rot

- Affects many vegetable & fruit crops
- Caused by Calcium (Ca) deficiency at growing point in fruit
- Drought stress during fruit set prevents transportation of Calcium



Disorders: Splitting Fruit

- Once fruit reaches mature color epidermis cannot expand
- High water input will cause fruit to 'split'
- Secondary fungal or bacterial pathogens quickly infect 'split' fruit



Disorders: Poor Fruit Set

- Insect or disease pressure
- Temps $< 50^{\circ}$ & $> 95^{\circ}$ F will prevent pollination and cause blossom abortion
- Excessive nitrogen fertility will cause vigorous foliage but low fruit set (all leaves, no fruit)

Tomato Cultivars

- Plum and Small Types
 - Smaller ($\frac{1}{2}$ " dia.)
 - Sweeter tomatoes
 - ~100 fruit/plant
 - 'Sweet 100'
 - 'Yellow Pear'
 - 'Black Cherry'
 - 'Tiny Tim'
 - 'Red Cherry'



Tomato Cultivars

- Beefsteak
 - Larger tomatoes
 - Excellent for fresh use
- ‘Beefmaster VFN’
- ‘Celebrity VFFNT hybrid’
- ‘Better Boy VFN’
- ‘Early Girl’



Tomato Cultivars

- Paste
 - High ratio of solids
 - Excellent for sauces
 - ‘Roma VF’
 - ‘Viva Italia Hybrid’
 - ‘Amish Paste’



<http://cornucopiaseeds.com.au/zencart/images/tomato%20indeterminate%20amish%20paste.JPG>

Tomato Cultivars

- Heirlooms
 - Older varieties
 - Open-pollinated
 - ‘Brandywine’
 - ‘Black Krim’
 - ‘Hungarian Heart’



Potatoes

- Family Solanaceae
- Tubers: Thickened, underground stems
- Asexually propagated



Potato Culture

- Plant small seed potatoes or cut into 1 to 1.5 inch sections with at least one eye
- Use of certified seed potatoes reduces disease issues
- Use 'hilling' as plants grow



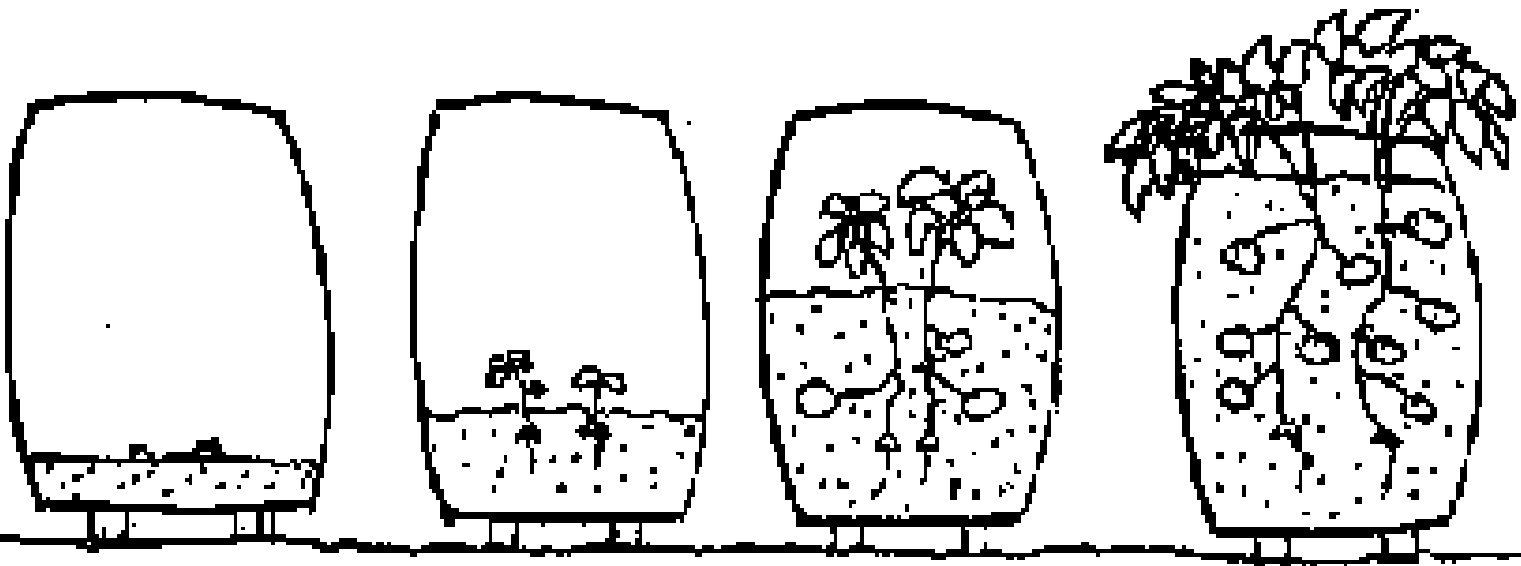
Hilling Technique

- **Hilling** involves piling soil up around the base of the growing vegetable
- Encourages development of additional tubers & reduces 'greening' – potatoes
- Provides plant support and adventitious root growth - tomatoes and peppers
- Creates longer stem growth – leeks
- Blanches the vegetable to keep pale, tender, and/or more appetizing - chicory, white asparagus

Potato Barrel Garden

- Use big pot, trash can, old barrel
- Drill holes in bottom and elevate
- Use 6 inches of soil and plant eyes
- Add soil as plant grows
- Harvest when plant has died
- Water frequently, when needed
- Protect from heat; don't bake your potatoes prematurely!

<http://www.rain.org/~philfear/garden.html>





<http://www.hostmoon.net/~bumblebe/storage/garbage%20can%20potatoes%20june%203%202007.jpg>

Potato Cultivars

- 'Kennebec' (white)
- 'Adirondack Blue'
- 'Adirondack Red'
- 'Norgold' (russett)
- 'Yukon Gold'
- 'Russian Banana' (fingerling)



Pea or Bean Family (*Leguminosae*)

- Green Beans
- Lima Beans
- Pinto Beans
- Great Northern Beans



Beans (*Phaseolus vulgaris* & *P. linensis*)

- Family Fabaceae (Leguminosae)
- Native to Central America
- Records of use as food date back to 5000 B.C.
- Self-pollinated
- Warm season



Bean Culture

- Bush or pole types
- Soak seed for an hour before planting to enhance germination
- Legume; soil may need to be inoculated with *Rhizobium* bacteria



Bean Culture

- Low humidity and high temperatures cause blossom drop
- Bush beans short growing season (50-60 days) may allow time for a fall crop prior to the first freeze

Bean Cultivars (*Phaseolus vulgaris*)

- **Bush**

- Erect plant, usually short season
- ‘Blue Lake’
- ‘Contender’
- ‘Tendercrop’
- ‘Topcrop’

- **Pole**

- require staking or trellising
- ‘Blue Lake’
- ‘Kentucky Blue’
- ‘Kentucky Wonder’

Cucurbits

- Squash
- Pumpkins
- Gourds
- Cucumbers
- Melons



Cucurbits

- Family Cucurbitaceae
- Warm season, herbaceous annuals
- Direct seeding is preferred
- May be bush-type (determinate) or vining (indeterminate) plants



Cucurbit Pollination

- Cucurbits bear *imperfect* flowers
 - flowers are either male or female
 - male flowers usually produced early
 - female flowers later
- Flower type determined by:
 - Genetics, day length, temps

Male Flower



Female Flower



Cucurbit Pollination

- Plants are ***monoecious*** (Both male and female flowers are produced by the plant)
- Can cross pollinate with other cultivars of the same species
- Bees critical for pollination



The Cucurbits: Pumpkins, Squashes and Gourds

<i>Cucurbita</i> Species	Pumpkins	Summer Squash	Winter Squash	Ornamental squash
<i>C. pepo</i>	Pie, Miniatures	Crookneck, Zucchini	Acorn, Fordhook	Gourds
<i>C. maxima</i>	Jack O Lantern		Hubbard, Banana	Turban
<i>C. moschata</i>	Crookneck pumpkins		Butternut	
<i>C. argyrosperm</i>	Cushaw		Cushaw	

Summer Squash

(Cucurbita pepo)

- Zucchini
- Scalloped
- Yellow crookneck
- Thin-skinned;
 - Eaten when immature
- Blossoms are edible



Summer Squash Cultivars

- **Zucchini**
 - ‘Gold Rush’
 - ‘Hybrid Jackpot’
 - ‘Black Magic’
- **Straightneck**
 - ‘Early Prolific’
- **Crookneck**
 - ‘Dixie’
- **Scallop or Patty Pan**
 - ‘Sunburst Hybrid’
 - ‘Peter Pan’



http://www.epicurious.com/images/articlesguides/howtocook/seasonal/cooknow_summersquash.jpg



Winter Squash

- *Cucurbita maxima, pepo, moschata, argyrosperma*
- Hard rinds make them good for storage
- Flavor and quality usually improved by 'curing'

Winter Squash Cultivars

- **Acorn (*C. pepo*)**
Green or gold & deeply ribbed.
 - 'Table Ace'
 - 'Table Queen'
- **Buttercup (*C. maxima*)**
Medium-dark green splotted with grey.
 - 'Autumn Cup'
- **Butternut (*C. moschata*)**
Orange flesh, tan skin, bulbous base.
 - 'Autumn Glow'
 - 'Early Butternut'
 - 'Waltham'
- **Delicata (*C. pepo*)**
 - 'Cornell's Bush Delicata'
- **Hubbard (*C. maxima*)**
Medium, blue-gray with bumpy skin.
 - 'Blue Hubbard'
- **Kabocha (*C. maxima*)**
 - 'Ambercup'
- **Spaghetti (*C. maxima*)**
Oval with golden yellow skin.
 - 'Pasta Hybrid'
 - 'Vegetable Spaghetti'

Melon

(Cucumis melo & Citrullus lanatus)

- Warm season, herbaceous annual
- May be determinate or indeterminate
- Melons can only cross pollinate with members of the same species
- Plants are monoecious
- May self- or cross- pollinate



http://farm1.static.flickr.com/231/464810982_e5172c2d66.jpg

Melon Culture

- Warm temps & sunny weather produces sweet fruit
- Best grown using mulch
- Bees essential for good fruit set
- Only allow 1-2 fruits to develop per watermelon plant for best quality



Harvesting Melons

- Harvest muskmelons at full-slip. 30-35 days after pollination
- Observe the “ground patch” (couche) on watermelon to determine when to harvest – it will become white to creamy yellow





Melon Cultivars

- Melons (other)

- ‘Casaba,
Golden
Beauty’
- ‘Crenshaw,
Early Hybrid’
- ‘Honey Dew,
Venus’

- Watermelon

- ‘Black
Diamond’
- ‘Crimson
Sweet’
- ‘Bush Sugar
Baby’
- ‘Moon & Stars’



Cool-Season Vegetables

- Highly or somewhat frost tolerant
- Seeds germinate at cool soil temperatures
- Tend to have shallow root systems

Cool Season Vegetables: Family Ties

Allium Family (*Allioideae*): Onions, Garlic, Leeks

Sunflower Family (*Asteraceae*): Lettuce

Parsley Family (*Umbelliferae*): Carrots, Celery

Goosefoot Family (*Chenopodiaceae*): Spinach, Beets,
Chard

Mustard Family (*Cruciferae*): Broccoli, Cauliflower,
Cabbage, Turnips, Collards, Kale

Allium Family (*Allioideae*)

- Onions
- Garlic
- Leeks
- Monocots



Onion / Garlic Culture

- Tolerant to frost or light freeze
- Shallow roots; water frequently
- Control weeds; *Alliums* don't compete well

Onions (*Allium cepa*)

- Valued for their pungent, distinctive flavor
- Native to southern Asia
- Fleshy, basal plate main portion consumed
- Biennial grown as an annual crop



Onion Planting

- Direct seed or use transplants
- Fall planting of onions allows for larger sized bulbs when harvested in the Spring

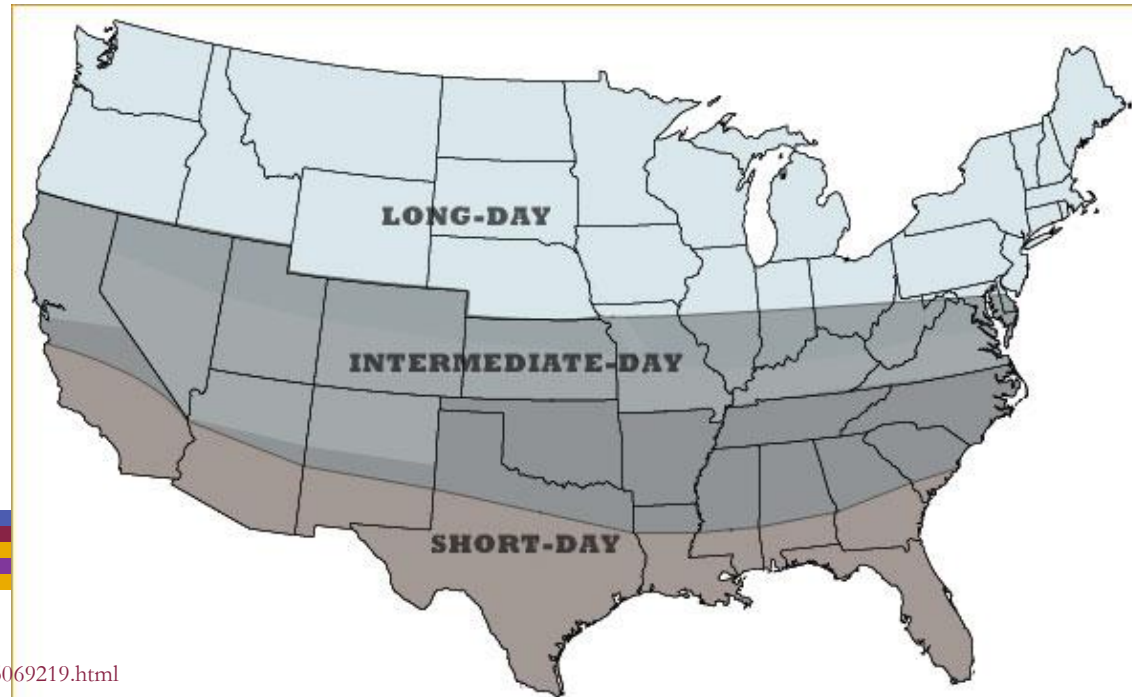
Onion Culture

❑ Day length critical to bulb formation:

Short-day: require 10-12 hours

Intermediate-day: require 12-14 hours

Long-day:
require
more than
14 hours



Onion Culture – Day Length

- **Short-day:** Bulbing begins early
 - If planted in the north, will produce small bulbs
- **Intermediate-day:** Most widely adapted
- **Long-day:** Includes most high solid, storage cultivars
 - If planted in the south, may not form bulbs

Onion Culture

- Harvest
 - May through August
 - Depends on variety
 - Seed vs. transplants
- Harvest when leaves begin to turn yellow and lodge
- Bolting may occur with cool spring temps
 - Plant resistant varieties



Sunflower Family (*Asteraceae*)

- Lettuce



Lettuce (*Lactuca sativa*)

- Herbaceous annual
- Four types:
 - Crisp head
 - Leaf
 - Butterhead
 - Romaine (Cos)



Lettuce Culture

- Plant in succession for prolonged harvest
- Temperatures above 70° F with long days cause lettuce to bolt
- High temperatures and excess maturity cause bitterness



Parsley Family (*Umbelliferae*)

- Carrots
- Celery
- Parsley



Carrots

Daucus carota var. *sativus*

- Family Apiaceae (Umbelliferae)
- Biennial, grown as an annual
- White, purple, yellow, orange, and red varieties



Carrot Culture

- Best growth between 59 to 65°F
- Temperatures below 50°F decrease color development and growth
- Prolonged high temperatures cause strong flavor and coarse roots



Carrot Culture

- Somewhat tolerant to frost
- Mulch heavily before freeze
- Harvest before a hard freeze



Carrot Culture

http://news.bbc.co.uk/2/hi/in_pictures/7725149.stm

- Heavy or rocky soil may prevent clean tap root development
- Carrot seedlings are salt sensitive; apply manure and fertilizer with care



Carrot Cultivars

- 'Imperator'
- 'Red Core Chantenay'
- 'Danvers Half Long'
- 'Nantes Coreless'



Goosefoot Family (*Chenopodiaceae*)

- Spinach
- Beets
- Chard



Spinach (*Spinacia oleracea*)

- Native to Iran
- Spina means “spiny”, Latin for prickly seed
- Hardy, cool-season annual
- High in vitamins A & C, calcium, iron, & potassium



Spinach Culture

- Tolerant to frost or light freeze
- Prefers growing temperatures between 55-65° F
- Tends to bolt and develop bitter flavor when maturing in hot weather
- Harvest older leaves to prolong harvest



Spinach Cultivars

- 'America'
- 'Winter Bloomsdale' (Savoy)
- 'Melody' (Savoy)
- 'Longstanding'
- 'Hybrid Tyee'
- 'Hybrid Avon' (Savoy)
- 'Giant Nobel'

Beets – Chard (*Beta vulgaris*)

- Beets and chard closely related (main difference is larger chard plants need to be thinned 4-6" apart)



Mustard Family (*Cruciferae*)

- Also known as brassica, cruciferous or cole crops
- Includes highly nutritious plants, grown for edible leaves, flowers, stems and roots
- Originated in the middle East
- Cultivated for centuries. Pliny the Elder described broccoli in first century A.D.

Mustard Family (*Cruciferae*)

- Broccoli
- Cabbage
- Cauliflower
- Collards
- Kale
- Turnips
- Radish
- Mustard greens



Broccoli (*Brassica oleracea* var *italica*)

- Cool season annual
- Tolerant to frost or light freeze
- Grown for it's edible, immature flower head
- Relatively tolerant to environmental stress
- Best quality when planted to mature in cool weather



Broccoli Culture

- Temperatures below 40° F may cause chilling injury
- Harvest when heads are firm and florets haven't begun to open
- Cut sprouting broccoli just below the floret to stimulate new shoots
- Button heads due to temperature extremes or nitrogen deficiency



Broccoli Cultivars

- 'Bonanza Hybrid'
- 'Green Goliath'
- 'Green Comet Hybrid'
- 'Emperior'
- 'Green Valient'
- 'Premium Crop'
- 'Hybrid Packman'



Cauliflower (*Brassica oleracea* var *Botrytis*)

- Somewhat tolerant to frost or light freeze
- Similar cultural requirements as broccoli
- Heads (curds) should be protected from full sun to prevent discoloring
 - Self-blanching varieties available



Cauliflower Varieties

- 'Snowball' (types)
- 'Snow King'
- 'Snow Crown Hybrid'
- 'Snowball Self-blanching'
- 'Graffiti' (purple)
- 'Cheddar' (orange)



Romanesco (*Brassica oleracea*)

- Also called Romanesco Broccoli or Romanesco Cauliflower
- Unique spiral pattern shape
- Sweeter, more delicate flavor than broccoli
- Quality improved by blanching developing head
- Spiral pattern not as pronounced when maturing in hot weather



Kohlrabi (*Brassica oleracea*)

- Also called Stem Turnip
- Grown for its enlarged, round, root-like stem (corm)
- Eaten as a baby vegetable (1-1.5") or full sized (about 'fist' sized)
- 'Kossak' extra large cultivar that reaches 8" dia.
- Greens eaten from young plants



Kohlrabi Culture

- Cool weather vegetable; fall planting window best for southern NM (temps $<20^{\circ}\text{F}$ lethal)
- Direct seed or transplant
- Similar management as cabbage



Important Sources of Information

Growing zones, recommended crop varieties, and planting and harvesting information for home vegetable gardens in New Mexico:

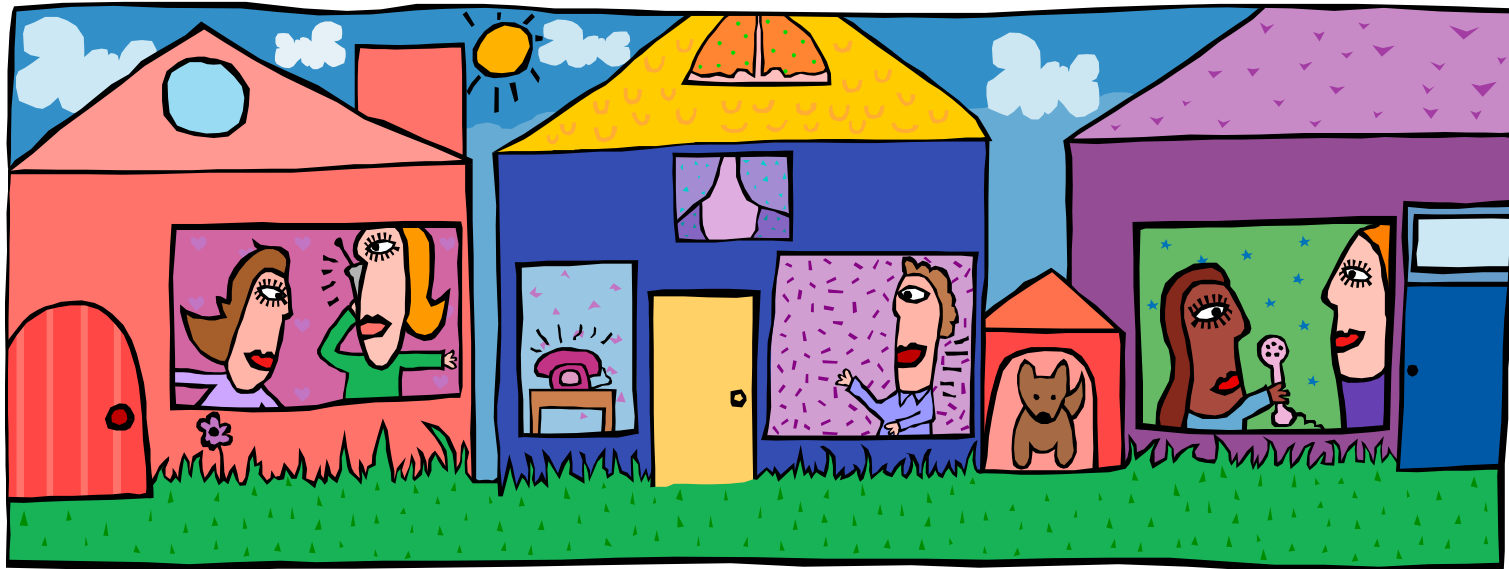
http://aces.nmsu.edu/pubs/_circulars/circ457B.pdf

Or, for a complete list:

http://aces.nmsu.edu/pubs/_h/

COMPANION PLANTING

Companion Planting Concepts



Companion Planting Concepts...

- Plants have predictable strengths and weaknesses when grown in set environments
 - Physical structure
 - Root growth
 - Phytochemical production
 - Susceptibility or resistance to diseases
 - Relative attraction to pests

Concepts

- Certain plants can benefit - or harm - others when placed in close proximity in the garden
- Actual scientific mechanisms not always understood
- Much of the information available is based on experiences and observations by many generations of growers

Scientific Basis

- 1) Trap Cropping
- 2) Symbiotic Nitrogen Fixation
- 3) Biochemical Pest Suppression
- 4) Physical Spatial Interactions
- 5) Nurse Cropping
- 6) Beneficial Habitats
- 7) Security Through Diversity

1) Trap Cropping

- A companion plant is used to attract pests away from the main plant
- Examples: Collards more attractive to diamond back moth; used to protect cabbage
Hubbard squash most attractive for squash bugs
- Be careful to not attract *more* pests to your garden

2) Symbiotic Nitrogen Fixation

- Nitrogen fixing crops are used to boost available N to a main crop
- Example: Use of legumes as companion crop
- Keep in mind-- most of the N fixed by the legume will be used by the legume; limited amounts will be available to the main crop

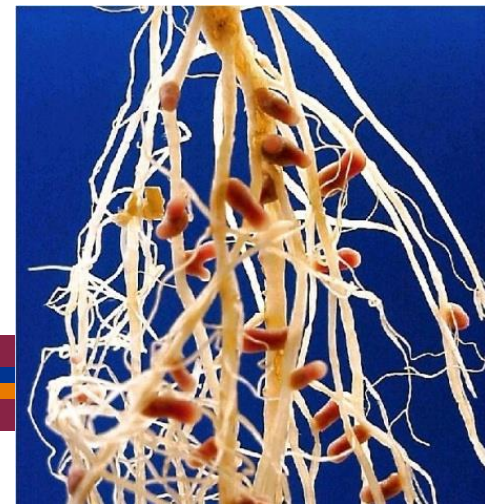
Nitrogen Fixing Plants

- Snap beans, string beans, peas, pinto beans, clover, alfalfa
- Generate plant available nitrogen from atmospheric N



Nitrogen Fixation Process

- Nitrogen fixation occurs in symbiotic relationship between Legumes and *Rhizobia* bacteria
- Compatible *Rhizobium* must be present in the soil; inoculation may be necessary
- Root hormone must be produced; plant must be in need of N





3) Biochemical Pest Suppression

- Some plants exude phytochemicals that suppress or repel pests or diseases; neighboring plants may also benefit
- Allelopathy. Examples: Black Walnut trees produce juglone.
 - Rye residue suppresses germination of weeds; transplanted tomatoes, broccoli do fine

Allelopathy & Fennel

- Fennel – highly allelopathic; inhibits growth or causes bolting for most garden plants
 - But, highly attractive to beneficial insects such as ladybugs, syrphid flies, parasitoid wasps
 - Repels fleas
- Remember the old saying, “plant fennel near your kennel”

Phytochemicals & Garlic

- Pungency is the result of sulfur containing chemicals
- Plant under peach trees to repel borers
- Plant under apple, pear trees to repel codling moths
- Repels aphids
- Good companion for cucumbers, peas, lettuce



Brassicas

- Broccoli, cabbage, cauliflower, brussels sprouts, kale, canola, turnips, mustards
- Produce isothiocyanates, sulfur containing compounds shown to reduce some soil pathogens
- May also inhibit seed germination of vegetables



4) Physical Spatial Interactions

- Pair tall, sun-loving plants with low growing shade to best optimize space
- Corn plants are believed to disorient adult squash vine borers; prickly squash vines may discourage vertebrate pests from dining on the corn
- Example: 'The Three Sisters'

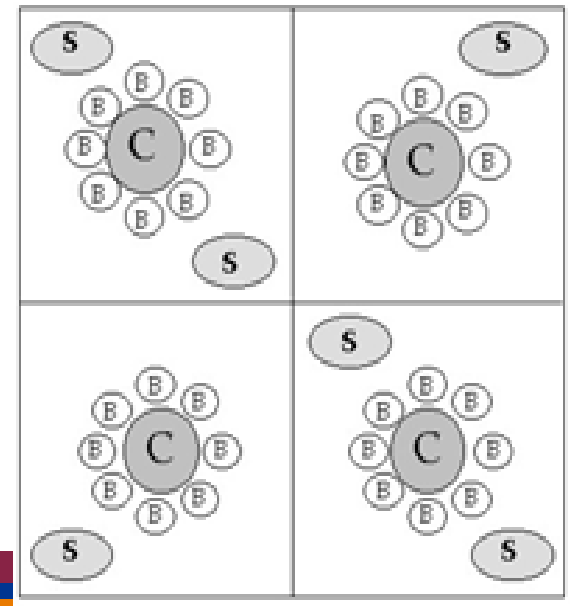
The Three Sisters

- Corn, Beans, and Squash benefit each other when planted closely together
- Corn provides support for beans
- Beans (legume) provide nitrogen to soil
- Squash leaves keep weeds suppressed



Zuni Waffle Garden

- Waffles are approx. 12' x 12'
- Each individual square is indented and surrounded by a high rim
- Sunflowers are often planted along the edges
- Allows maximum water efficiency in arid, southwest climate



5) Nurse Cropping

- Tall or dense-canopied plants may provide a wind break to delicate companion plants
- Oats have long been used to prevent weed growth and allow for establishment of alfalfa or other forage crops

Oats in Chile Field



6) Beneficial Habitats

- A companion plant provides a desirable habitat for beneficial insects and other arthropods



Flowering Plants – Beneficial Companions

- Chamomile
- Chrysanthemums
- Geraniums
- Lavender
- Marigolds
- Nasturtiums

Chamomile

- Use German Chamomile (*M. chamomilla*), not Roman (*A. nobilis*)
- Companion for cabbage and onions
- Attracts beneficial insects including hoverflies and wasps
- Grow sparingly; one plant every 150'



Chrysanthemums (*cinerariaefolium* species)

- The widely used insecticide, pyrethrum, was first extracted from chrysanthemums
- Root exudates kill root knot nematodes



<http://www.mums.org/journal/index.htm>



Geraniums (*Pelargonium* species)

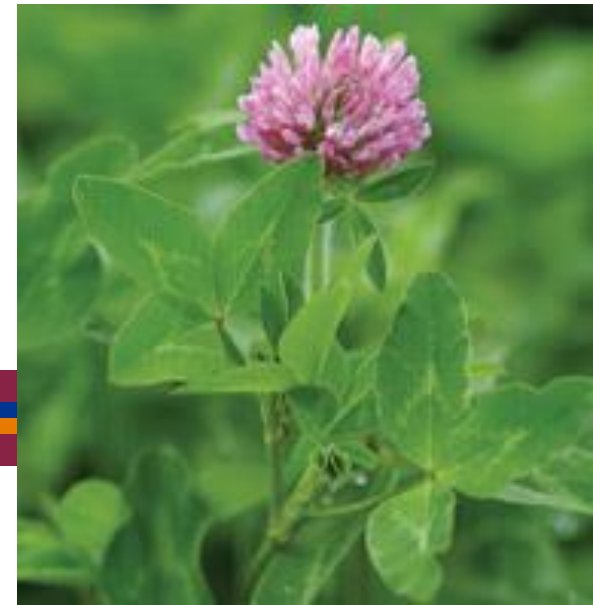
- Repels cabbage worms
- Good companion for grapes, roses, corn, cabbage
- Good companion for tomatoes and peppers, however
 - carrier of curly top virus
 - may 'distract' beet leafhoppers



Beet leafhopper
[Picture by J. Appleby]

Clover

- Legume; nitrogen fixation
- Good companion to grape vines
- When planted with cabbage, has been shown to interfere with invasion by aphids and cabbageworm
- Attracts beneficial insects



Marigolds (French, *T. patula* and Mexican, *T. minuta*)

- Repels many harmful insects including whiteflies
- Roots of French Marigolds exude chemicals that kill root knot nematodes
- Mexican Marigolds may have herbicidal effect on weeds, including bindweed
- May inhibit growth of beans and cabbage

Nasturtiums

- Good companion for radishes, brassicas
- Trap crop for aphids, squash bugs, cucumber beetles, whiteflies
- Can be planted as living, protective barrier around tomatoes, cabbage, and cucumbers
- Excellent for attracting beneficial, predatory insects



7) Security Through Diversity

- ‘Not putting all your eggs in one basket’
- Univ. of Cal. research demonstrated that mixing of broccoli cultivars can reduce aphid pressure
- Combine vegetable crops in your garden with beneficial companions

Intercropping

- Plant two or more crops in the same space
- Avoid wasting 'unused' space
- Take advantage of difference in growth rate; harvest quick maturing crop while slower maturing crop is still growing to full size
 - Carrots and radishes
 - Cabbage and lettuce



VEGETABLE PREFERRED COMPANIONS

Carrots

- Companions: Tomatoes, Peas, Lettuce, Rosemary, Onion, Sage (repel carrot fly)
- Incompatible: Dill



Brassicas

- Includes Broccoli, Cabbage, Cauliflower, Collards, Kale, Turnips, Radish, Mustard
- Companions: Beets, Onion, Spinach, Chard, Potatoes
- Incompatible: Beans (Pole), Tomatoes, Dill, Strawberries



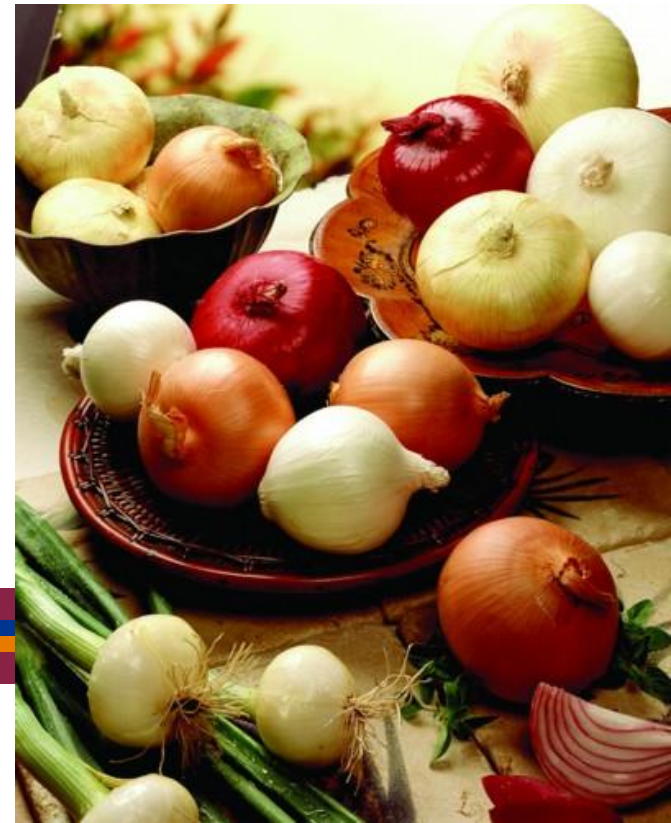
Corn

- Companions: Potato, Beans, Peas, Pumpkin, Cucumbers, Squash
- Incompatible: Tomatoes (Tomato Fruit Worms like both!)



Onion

- Companions: Beets, Carrot, Lettuce, Brassicas
- Incompatible: Beans, Peas



Lettuce

- Companions: Carrot, Radish, Strawberry, Cucumber
- Incompatible: ?



Tomatoes

- Companions: Onion, Asparagus, Carrot, Cucumber
- Incompatible: Potato, Brassicas



SUCCESSION PLANTING

Succession Planting

- Involves staggering your plantings to extend your harvest
- Quick maturing or determinant (bush-type) crops best



Succession Planting – Vegetable Selection & Timing

7 Days	10 Days	14 Days	21 Days	30 Days
Baby Greens	Lettuce (head)	Beets	Carrots	Summer Squash
Radishes	Kohlrabi	Arugula	Cucumbers	Swiss Chard
Spinach	Peas		Mustards	
	Sweet Corn		Melons	
	Beans (bush)			

Succession Planting

- Plant vegetable crop at earliest 'planting window', then continue at recommended interval through the remainder of the season
- Season extension techniques can be used to get earlier start to planting



Burpee.com



<http://www.naturemoms.com/blog/wp-content/uploads/2008/02/milk-jug-cloche.jpg>

Row Covers

- Hoop supported vs. floating
- Perforated polyethylene vs. spun bonded polyester or polypropylene
- Provides a 2 to 4°F temperature boost
- May provide protection from insects



Succession Planting

- After harvest, immediately replant the space
- Intercropping can be used to further optimize production from a limited space
- Take care of your soil; replenish nutrients

In Conclusion...

- Benefits of companion planting have been observed throughout history, however the exact mechanisms have not been fully explained
- Each producer must observe and note their results and plan accordingly

Planning for Harvest

- Set up a Gantt chart/calendar for your garden
- Which vegetable?
- What is planting window?
- How long until harvest?

Planning Example

- 'Crispino' head lettuce
- Optimum planting window for Area 3:
April 1 – June 15
- Succession planting every 10 days
- Matures in approx.
57 days



Gantt Chart Example

Tomato	Mar	Apr	May	Jun	Jul	Aug	Sep
Oregon Spring		★		★			

57 days to harvest

- ➡ First planting, **April 1** (start of optimum planting window) – harvest **May 28**
- ➡ Second planting, **April 11** – Second planting - harvest **June 7**

Sources of Information

- “Carrots Love Tomatoes”
“Roses Love Garlic”
author: Louise Riotte
- National Sustainable Agriculture Information Service / National Center for Appropriate Technology
- <http://attra.ncat.org>

Thank You

