Tuber Crops

- Potato
- Jerusalem artichoke
- Yam
- Enlarged stolons
  - Underground stems

Potato

- Solanaceae Family
- *Solanum tuberosum*
  - Approximately 2000 *Solanum* spp., 160 form tubers and 20 are cultivated
- Center of Origin: Andes of South America
- Cool season, Perennial, vegetatively propagated
- Irish potato famine caused by late blight in 1846
  - Destroyed the crop, caused a great famine, and Irish immigration to US
  - Hence, "Irish" potato

Potato Industry

- Number 1 vegetable crop in the US (acreage & value)
  - Per capita consumption over 145 lbs/person
  - 50 lbs fresh, 60 lbs frozen, 15 lbs chips, 17 lbs. dehydrated & 2 lbs canned
- Grown year-round in US, but mostly as a summer crop with a fall harvest
Plant Growth & Development

• Three development phases
  – Emergence and early development
    • Mostly leaf & stem growth
  – Tuber initiation
  – Tuber enlargement & maturation

Emergence & Early Development

• Stems develop from a seed tuber or cut piece of larger tuber
• Usually several upright stems up to 3-1/2’
• Stems become bushy as they age, may eventually become prostrate before senescing
• Roots arise at the underground nodes of the main stem
  – Usually remain in top 24” of soil

Tuber Initiation

• Tubers are enlarged portions of underground stems
• Arise at nodes of the main underground stem, usually within a week after the above ground shoots emerge
• Tubers are storage organs with surplus carbohydrates
• Initiation results in rapid cell division
  – By the time the tuber is ~1/2” in diameter, most of the cells in the final tuber are formed
Tuber Enlargement

- Tubers are swollen stems with buds (eyes) in a spiral pattern around the stem.
- As the tuber enlarges, the epidermis is sloughed off and a layer of cork cells cover the surface (periderm).
- As the tuber matures, the periderm toughens, the starch content increases, and the water content decreases, increasing the specific gravity (dry weight).

Shoot/Tuber Relationships

- Yield & quality of tubers is directly dependent on available carbohydrates from the foliage.
- Requires early vigorous shoot/leaf growth to have photosynthetic capacity.
- Plant draws on carbohydrates in seed piece during first several weeks of development.
- Once tubers are initiated, they are in direct competition with the rest of the plant.
- Anything that decreases photosynthesis or increases respiration will retard tuber growth.

Tuber Dormancy & Dominance

- Tubers undergo a rest period (dormancy) following maturation.
- The dormancy period may range from 1-3 months depending on the variety.
  - Following dormancy, the eyes will begin to germinate unless prevented by temperature or chemicals.
  - Dormancy can be broken by cool-warm temperature treatment or by hormone treatment.
- The apical eye (bud nearest the apex) exhibits strong dominance.
  - Planting whole tubers usually results in only a few of the buds germinating into stems.
  - Extended dormancy periods reduce the level of this dominance.
Climatic Requirements

- Potatoes strongly influenced by daylength and temperature, and varies depending on the stage
  - Vine growth:
    - Long days
    - Optimum temperature: 80-90°F
  - Tuber initiation:
    - Short days
    - Optimum temperature: 59°F
  - Tuber development:
    - Optimum temperature: 70°F day and <57°F night
    - Low night temperatures reduce respiration
  - Lower temperatures will result in more tubers (initiation frequency higher) but they will be smaller
  - Potatoes (a cool season crop) can be grown in climates with high temperatures (100°F+)
    - Adequate supply of water
    - Cool nights

Cultural Requirements

- Soil types
  - Light soils best (like rooted crops)
  - Require good aeration
    - Excess moisture reduces yields, favors above ground growth over tuber growth
- Fertility requirements
  - Potatoes are in the group of vegetables with the highest fertility requirements
  - Shallow root system

Planting & Crop Establishment

- Potatoes are vegetatively propagated via tubers
- Certified Seed (tubers)
  - State agencies inspect production fields and stored seed potatoes and certify the seed as being true to type and disease-free (within a range)
- Potatoes do produce true seed, but with few exceptions, not reliable:
  - Tetraploid: low seed yield
  - Heterogeneous: True seed will segregate
Planting & Crop Establishment

- Small uncut tubers (1-2” diameter) often used in commercial fields
  - May result in a better stand and higher yield
  - Less chance of spreading disease
- Cut pieces are cheaper, diminish apical dominance resulting in more rapid emergence, produce more total sprouts and more uniform sprout development
  - Cut pieces must contain at least one eye
  - If pieces too small, will result in weak plant
- Seed should not be planted right out of storage
  - Will undergo a “sweat” period that favors decay
  - Should be warmed for several days prior to planting

- Soil temperatures should be >40°F
- Commercial fields are planted with 2-row or 4-row planters
- Spacing may range from 6” to 16”
  - Wider spacing generally results in larger tubers
  - Un-cut seed potatoes tend to produce more smaller tubers than cut seed, so are usually spaced farther
  - Cultivars differ in number of tubers and size, so are spaced accordingly to provide the desired tuber size

Cultural Practices

- Potatoes are usually grown in ridged rows to prevent sunlight from reaching tubers
- Cultivation should be held to a minimum because of shallow root system and tubers forming near the surface
- Potatoes compete with weeds better than most vegetables
Pests and Diseases

- Insects
  - More than 25 insect pests attack potato
    - Colorado potato beetle
    - Flea beetle
    - Leafhoppers
    - Aphids
    - Potato tuberworms
    - Grubworms & wireworms
      - If planted following sod or grass

Pests and Diseases

- Diseases
  - Many diseases, many are seed-borne
    - Late blight (Phytophthora infestans)
      - Historically the major disease foliar of potatoes
    - Scab
      - Superficial or pitted corky lesions on infected tubers
    - Mosaic Diseases
      - Potato Virus X, Potato Virus Y
      - Seed-borne

Physiological Disorders

- Greening of tubers (chlorophyll development)
  - Results from exposure to light
  - Problem caused by solanine, which is bitter tasting and toxic
- Hollow heart
  - Cavities in the center of tubers
  - Caused by irregular growth patterns
- Blackspot
  - Bruising of tubers
  - Usually occurs on immature tubers
Harvest and Postharvest

• Early-crop potatoes usually go straight from the field to market without storage, and tubers are usually not fully mature
• For storage potatoes, maturation is critical for maximum shelf-life
  – To achieve full maturation, the vines are usually killed about 2 weeks prior to harvest
  – Vine killing induces the tubers to "suberized" forming a tough skin, making the tubers more resistant to bruising

Sprout Inhibition

• Once the "rest" period has past, tubers will sprout if conditions are right for growth
  – Usually when temperatures rise above 40°F, but especially when temperatures reach 60°F
• Since these temperatures are close to storage conditions, sprout inhibitors are usually used to prevent sprouting during storage
  – Some are applied to foliage 2-3 weeks prior to harvest
  – Some are applied to tubers during their holding period
• Cold temperatures will prevent sprouting, but will also favor conversion of starch to sugar, which reduces quality especially for processing potatoes

Harvest and Postharvest

• Commercial potatoes are machine harvested with one or two row harvesters
• Early-crop potatoes are usually washed in chlorinated water and sent to market
• Storage potatoes undergo three phases to prolong shelf-life and maximize quality:
  – Curing
  – Holding
  – Removing
Harvest and Postharvest

• Curing
  – Held at 55-60°F, high relative humidity for 2-3 weeks
  – Promotes healing of cuts and bruises

• Holding (depends on use of crop)
  – Seed or table stock: 38-40°F
  – Processing requires higher temperatures to prevent the conversion of starch to sugars:
    • Chips: 50-55°F
    • Frozen or dehydrated: 42-45°F

• Removal
  – If held for prolonged period, may need to recondition the tubers to reduce damage from handling and reverse changes of starch to sugar
  • 50-60°F for 2-3 weeks

Jerusalem Artichokes

• Compositae Family (Sunflower)
• *Helianthus tuberosus*
• Plant resembles sunflowers (4’-8’ tall)
• Perennial, grown as annual
• Native to North America
• Vegetatively propagated via tubers
• Uses similar to potato
• Primary carbohydrate reserve in tubers is inulin, a polymer of fructose that can be utilized by diabetics in lieu of glucose