Pea (*Pisum sativum* L.)
Characteristics for Use and Successful Planting

'Whistler' winter pea. Seeded on 9/15/17 at the USDA NRCS Big Flats Plant Materials Center. Photo taken on 11/5/17.
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Peas (*Pisum sativum* L.) are one of the world’s oldest domesticated and cultivated legume crops. Throughout its history in genetic research, peas have undergone numerous selections and breeding for characteristics desirable for cultivation, consumption, and other uses (Jing et al. 2010). There are a handful of subspecies within *P. sativum* with differences in major traits and in their occurrence throughout the world (Cousin, 1997). The most common pea varieties in the US, as defined by Maxted and Ambrose (2001), GRIN, and ITIS are:

- **Garden peas** (*P. sativum* (L.) var. *sativum*) - are produced primarily for human consumption and must adhere to certain market standards;
- **Field peas, dry peas, or Austrian winter peas** (*P. sativum* var. *arvense* (L.) Poir. - used for livestock feed (dry seeds or green forage), green manure and as a cover crop, but can also be used for human consumption;
- **Sugar, snap, and snow peas** (*P. sativum* var. *macrocarpon*) - used for their edible pods.

A major problem farmers run into is which variety to purchase for their operation. The variety of pea used depends on attributes for cultivation and/or consumption as well as environmental benefits. When choosing a pea variety, several questions need to be asked:

- Are the end uses for human consumption, animal feed, or cover crop?
- What disease and insects are most prevalent in the area?
- Is the target planting date spring or fall?
- Do the historical soil characteristics meet the needs of the plants?

Cultivars adapted to late summer/fall planting have been developed for use as a winter cover crop in the northeast US. Pea (*Pisum sativum* var. *arvense*) cultivars that have the following characteristics are ideal:

- high yielding
- earlier maturing
- increased winter hardiness
- disease and insect resistance
- high N-fixing abilities
- low cost, high-quality seed

However, ultimate productivity and usefulness depends on adaptability to environmental and climatic conditions. Not every cultivar will have all the traits needed, so proper planning will help ensure the correct cultivar is selected for its primary use in a farming operation.

**Characteristics**

Peas are available that differ in their cotyledon color, plant form, ideal seeding time, winter hardiness, seed properties, flowering time etc. Characterizing the diversity in pea is beneficial both for conservation and other end uses in the feed and human markets.

Peas are annual, cool season legumes that can be planted in the fall/winter or spring. They grow best when average daily temperatures are 55-65°F. Peas have hypogeal germination, meaning the shoots germinate below the soil surface making them more tolerant to frost. Peas are self-fertile. In cooler regions, with adequate rainfall, they tend to flower earlier and mature later than in areas experiencing drought conditions or other stressors.

Phenological characteristics, such as germination, flowering and flowering duration, seed set, and other stages of growth can differ immensely (Fenner, 1998). Genetics, weather, climate, and soil conditions, diseases, competition, etc., will heavily influence growth throughout life. Some
Cultivars are adapted to specific conditions while others can be used more broadly. Knowing which characteristics are best adapted to an area, will aid in successful plantings. Morphological characteristics are highly variable due to environmental influence and genetics associated with local ecotypes. Traits such as flower color, cotyledon color, seed coat color, seed coat pattern, and seed surface texture, are important in feed and human markets, and also have implications to its use as a winter cover crop. Below are some common characteristics that will aid in selecting an appropriate cultivar for a farming operation (Cousin, 1997) (Krall et al, 2006).

Leaf types. Leaf type can signify a pea cultivars ability to withstand harsh conditions (Heath, and Hebblethwaite 1985b) (Endres et al, 2016).

- **Normal leaves**- 1-3 pairs of leaflets, terminal branched tendrils and stipules with vine lengths of 4-6 feet.
  - higher biomass and yields therefore, more competitive against weeds;
  - best for forage use especially when mixed with a cereal grain.

- **Semi-leafless**- modified leaflets reduced to tendrils and normal stipules with vine lengths of 2-4 feet.
  - less leaf area but better resistance to lodging;
  - best for mechanical harvesting if growing for grain;
  - decreased susceptibility to fungal diseases;
  - higher seeding rates needed for weed suppression use;
  - best for grain (dry pea) use;
  - also referred to as afila (af).

- **Leafless**- leaflets reduced to tendrils
  - small seeds to reduce plant growth-rate;
  - non-branching, branches add little to yield at high density;
  - early flowering.
**Growth Habit.** Growth habit develops from specific genetics in combination with environmental factors. Water availability, especially during the growing season, is the single most important environmental factor limiting pea growth habit. Competition for nutrients, space, and light (Endres et al, 2016) are also factors.

- **Tall-vine length, indeterminate-**
  - better for areas that experience heat and drought stress especially during reproduction;
  - bloom throughout the summer until temps and moisture become limiting;
  - develop a dense canopy, with long vines, producing more biomass;
  - terminal bud continues to grow and stay vegetative while conditions allow even when flowers are forming;
  - harder to harvest because of more lodging;
  - tend to be more winter hardy, and usually seeded late summer/fall, or late fall.

- **Short-vine length, determinate-**
  - early maturing due to faster growth rate and best when spring planted;
  - more upright growth;
  - best for grain use.
  - recommended for areas with shorter growing seasons, higher rainfall and cooler summer;
  - flower for a set period.

- **Branching (Indeterminate or Determinate)-**varies among cultivars and can be affected by environmental influences.
  - Austrian winter pea types, with increased winter-hardiness, produce multiple branches that trail along the ground in the fall and winter
  - produce high amounts of biomass prior to flowering
  - use as a green manure, cover crop or forage.

**Flower Color.** One of the first and most studied pea attribute in genetics. Lacking pigmentation signifies the lack of anthocyanin content and makes the seed more palatable.

- **Purple**- associated with reddish purple axil color and purple dots on seed coat. Austrian winter pea type or Maple peas. Less palatable;

- **Pink**- reddish leaf axils, reddish dots on seed coat;

- **White**- associated with a clear seed coat and no leaf axil color. Lack of anthocyanins for a sweeter taste. Constitutes most grain and vegetable types.

**Seed Characteristics.** These traits differ significantly based on cultivar selection and increase value as a cash crop.

- **Shape and Surface texture**
  - *smooth and round*- most often used as dry edible peas (grain peas). Allows for easier seed coat removal. Usually more starch and not as sweet.
  - *angular, wrinkled, and dimpled*-primarily used as a protein and energy source for livestock. They may be more sensitive to high temperature. Have the capacity to collect more water and usually are less starchy. Mostly used in human markets.
• **Seed Cotyledon Color**- important for edible market class peas, but can be used in the food and feed markets.
  - *yellow*-not utilized as much as a fresh vegetable. The chlorophyll is lost as the seeds mature but may not turn from green to yellow if they do not reach maturity.
  - *green*-intensity of color is important for human consumption markets. However, green peas can be bleached by sunlight to appear yellow. They generally lag behind yellow pea varieties regarding yield potential, powdery mildew tolerance, and standability; however, there are several notable exceptions (Pulse USA).

• **Seed Coat Color**- signifies variations in the content of tannins and is important for edible market. (Lazarević et al., 2016).
  - *colored*- can be brown, gray, purple, and green with various shades of each. Signifies natural protection to various root rot diseases.
  - *clear/colorless/white*- associated with white flowers and have less tannins.

• **Seed Coat Pattern**
  - *mottled-* associated with colored flowers. A gray seed coat are not acceptable for human consumption markets. Used primarily as animal feed or lower grade grain;
  - *no mottling-* better for edible food markets;
  - *violet or black eye-* can have colored or white flowers, (i.e. black eyed peas);
  - *mapling-* associated with colored flowers, and wild types (i.e. maple peas).

• **Seed Size**- this is mostly driven by market requirements and will vary considerably among and within cultivars. It will also determine seeding rates and must be adjusted for proper planting density. Growers should do a seed count on each seed lot before seeding.

**Agronomic Characteristics** Peas may not be as profitable as corn or soybeans, but agronomic benefits for subsequent crops are insurmountable. To achieve maximum benefits, best agronomic practices need to be implemented according to the cultivar used. These practices include careful site selection and site history, attaining high quality seed, and after planting management. Consideration to end use can also have a substantial impact on the crop’s intrinsic value.

• **Planting date**- Choose the appropriate type below. Do not plant spring cultivars in the fall as they will not over winter. This could also be determined by the origin of the cultivar (i.e. winter types from southern regions are usually not adapted to the winter conditions of northern US climates). Check for results from local variety trials.
  - *spring types*- after last frost, and as early as possible.
  - *fall/winter types*- after wheat harvest or end of August to Oct 1, at the latest.

• **Yield**- Yields can be variable due to different biotic and abiotic environmental stresses as well as planting dates of pea varieties (winter or spring type). In winter peas, planting by late summer will increase yield potential and limit the effects of winter (frost tolerance). In both spring and winter peas, drought and heat stress during flowering will have significant impacts on seed production (Martin et al, 1994).

• **Soils**- Peas are adapted to a wide variety of soil types and conditions (Kumari et. Al. 2015) (Endres et al ,2016), from sandy loams to heavy clays. They also:
  - tolerate soil pH 5.5 to 9.0, but perform best when pH ranges are 5.9 to 7.5;
prefer well-drained soils that do not have standing water or are water-logged. Can tolerate heavy clay soils, but not ideal for optimum growth and production;
- will germinate at a soil temperature of 40°F. Emergence normally takes 10 to 14 days;
- need ample soil moisture when seed is being established for optimal germination;
- low tolerance to saline conditions.

- **Disease and Insects**- Pea can be used as a break crop for disease control and will improve soil fertility. Below are some of the major diseases effecting peas (Cousin, 1997):
  - Ascochyta blight;
  - powdery and downy mildew;
  - fusarium wilt and root rot;
  - pea common mosaic, pea enation mosaic and pea seed-borne mosaic.

- **Nitrogen-Fixation**- Peas have a taproot but most of the secondary roots are within the top soil layers (Endres et al 2016). The roots form a symbiotic relationship with soil bacteria to form nodules that fix atmospheric nitrogen for plant use. Inoculate pea seed or apply directly to soil for growth and N-fixation. Root nodules will start to form in about 2 weeks after emergence. If nodules do not form, plants will become yellow or pale green with decreased growth. To identify if nodulation is progressing, dig up roots from several plants. Effects can be caused by herbicide use, soil pH, soil type and drainage. Things to keep in mind when seeding peas for their N-fixing abilities:
  - peas are among the most highly efficient nitrogen fixing crops;
  - seed must be properly inoculated - *Rhizobium leguminosarum*;
  - high temperatures and dry soils during the later vegetative and early reproductive stages are especially detrimental for N-fixation.

**End-Uses**

- **Grain and/or human consumption**- Provides a source of protein when used in the immature or mature stages. Best characteristics are:
  - spring types, early maturing, semi leafless, semi dwarf stature and determinate growth;
  - white flowers, short vines and nodes, with light seed colors.

- **Forage and green manure**- Peas when compared to other winter forages, lack ample regrowth after grazing. Due to their weak stems and surface roots, little stubble is left after harvest or grazing and will not provide erosion control and must be carefully monitored. The best characteristics for peas as a forage and cover crop are:
  - winter hardy, semi leafless or normal leaves, indeterminate growth habit with multiple branches;
  - purple flowers, longer stems, dark seeds with mottled seed coats, normal leaves (Austrian winter peas), and smaller seed size.
**Summary:**
Each of the above-mentioned characteristics are important to pea breeders, growers and farmers for multiple uses. The genetic combinations encountered today resulted from evolutionary adaptation, climatic conditions, natural mutations and formal breeding for crop use as well as aesthetics (Jing et.al 2010).

- When selecting a site for peas, make sure to consider the following variables:
  - Research available cultivars (See Appendix 1).
  - Rainfall greater than 12 inches per year in planting site;
  - Soil is well-drained, with a pH between 5.5-9.0, relatively flat surface, and no hardpans;
  - Peas were not planted in the previous years or planted close to other fields containing fungal diseases;
  - Relatively weed free and hard to control weeds are eradicated before seeding.

- To be considered food quality, seeds must be smooth, large, and have a clear seed coat and hilum. The quality of the characteristics of the harvested seed and not the planting date dictate which markets they are be used.

- When selecting a cultivar for cover cropping in the Northeast, use a tall, normal leaf pea with long vines. It will produce more biomass, fix more nitrogen and suppress weed growth, especially in the spring, than a tall, semi-leafless cultivar. However, there are cultivars of semi-leafless, with white flowers and clear seed coats available that are winter hardy.

**References:**
Appendix 1.

Some available pea cultivars. The peas listed below were field tested as part of the USDA NRCS Plant Materials Program’s, National Cover Crop Adaptability Study. Visit the Plant Materials Program’s website for more details (link below).

https://www.nrcs.usda.gov/wps/portal/nrcs/main/plantmaterials/pmc/

Peas (*Pisum sativum* L. and *P. sativum var. arvense* (L.) Poir)
The recommended seeding dates and rates below are from the seed company’s website or fact sheets and may or may not be accurate for all end uses. Adjust seeding rates and dates accordingly to your area’s climate and soil conditions. It is not recommended to broadcast pea seed due to its relatively large seed size and hypogeal germination.

‘Arvica’ spring field pea- Not for use as a winter cover crop in the Northeast US
- rapid spring growth, mostly for forage
- long vine, normal leaf and high yielding for forage
- purple (or lavender) flowers
- approx. 3500-4000 seeds/lb with very durable seed-coats and excellent seedling vigor.
- contains a small % of hard seed
- **seeding date**: as early as possible in the spring; Not suited for fall planting
- **seeding rate**: 30-100 lbs/Acre depending on alone or in a mix.
- Usually planted with a cereal grain

‘Lynx’ winter field pea
- released by USDA ARS and Central WA Grain Growers for use as a component in wildlife food plot mixes
- winter hardiness to °5 and low rainfall areas
- improved disease resistance
- white flowered, green cotyledons and clear seed coat- Excellent palatability
- short internode, semi-leafless, semi dwarf stature
- resistant to mosaic virus
- **seeding rates**: 30-100 lb/acre
- **seeding dates**: plant in late summer to fall when adequate soil moisture is available
‘Maxum’ winter field pea
- green forage-type field pea
- days to maturity or bloom: 52-75
- dry yellow peas
- purple flowers
- seeding dates: spring or fall
- seeding rates: 120 lb./acre

‘Survivor’ winter field pea
- very winter hardy, normal leaves, white flowers
- quicker establishment than other winter hardy varieties
- released by Grassland Oregon

‘Whistler’ winter field pea
- semi-leafless, with white flowers and yellow cotyledons- very low anthocyanin content
- greenish-yellow seed coat- for feed market
- approx. 2,800 seeds/lb
- winter hardy to 0º F
- medium maturity
- susceptible to powdery mildew, but tolerant to root rot
- seeding rates: 50-70 lb/acre

‘Frost Master’ winter field pea
- white flowers, long-vine, and normal, large leaves
- exceptional winter hardiness
- high biomass producer
- seeding date: Sept.-Oct. (depending on where located); can be spring seeded
- seeding rate: 75-100 lbs./A (broadcast); 50-70 lbs./A (drilled); 100-150 lbs./A (soil nitrogen fixing).
‘Windham’ winter field pea

- winter growth habit (elevated winter hardiness)
- semi-leaf less; semi-dwarf upright; white flowers, medium vine length
- small, clear, mottled seed coat that is smooth, round with yellow cotyledons
- flowers at the 18th node, reaches 50% bloom ~21 days prior to traditional spring sown types
- ~3000 seeds/lb
- resistant to Fusarium wilt, but lacks resistance to Fusarium wilt race 2, pea enation mosaic virus and powdery mildew (caused by Ersiphe polygoni)
- multiple end uses- dry seed, forage, green manure