Planting and Stand Establishment

A uniform stand of healthy plants increases the chance for success for the remainder of the season. The final plant population is determined by interactions of weather, seed quality and field conditions. During this stage, growers need to pay close attention to seed quality; plant density and spacing; planting dates; and stand establishment.

Seed quality

Seed quality determines timely and uniform seedling emergence and ultimately cotton yield and quality. The major advantages of high-quality planting seed are outlined in Table 4.1.

Seed quality can be measured using the Cool-Warm Vigor Index, which combines information obtained from two seed evaluations: the Standard Warm Germination Test and the Cool Germination Test.

Table 4.1. Major advantages of high-quality planting seed.

Greater resistance to seedling disease organisms
Uniform stand establishment and enhanced earliness
Tolerance of early-season stresses
Tolerance of deeper planting depths
Reduced risk of replanting
Improved chance of achieving optimum planting date
Assurance of a stand at lower seeding rates
Rapid seedling emergence
Higher harvesting efficiency because of uniform seedling emergence
Improved harvest aid program because of uniform plant size
Easier decision making for weed, insect and disease control

The Standard Warm Germination Test measures the percentage of normal seedlings that have a combined hypocotyl and root length of 1.5 inches after being placed in an incubator for 4 days at 68 degrees F for 16 hours a day and 86 degrees F for 8 hours a day. The hypocotyl is the portion of the stem below the cotyledons (seed leaves). In the Cool Germination Test, the seeds incubate at 64 degrees F and the percentage of normal seedlings with a combined hypocotyl and root length of 1.5 inches is calculated after 7 days.

The results of the two tests are added together. Seed lots are then classified as poor, fair, good or excellent (Table 4.2).

Table 4.2. Cool-Warm Vigor Index values.

Category	Value (% Cool Germination + % Warm Germination)
Excellent	160 or greater
Good	140-159
Fair	120-139
Poor	Less than 120

The seeds with the highest vigor index value may be planted at the earliest possible planting date, when less than optimum conditions are likely to occur. A producer can then follow with seed from a lower vigor index value level as the planting season progresses and soils become warmer.

The results of the Cool-Warm Vigor Index are not printed on seed tags, but growers can obtain them from the seed company or dealer. Request this information on all seed before buying. It will help you determine the sequence in which to plant the seed lots.

Variation in seed quality is common (Table 4.3). Seed with a cool germination of 50 percent or higher can germinate under a wide range of

Table 4.3. Results of seed quality survey conducted on 28 varieties used in field demonstrations in the Coastal Bend region, 1988.

Standard Warm Test		Cool (Stress) Test	
% of Varieties	Range in Germination %	% of Varieties	Range in Germination %
14	75 or less	18	30 or less
25	75-85	36	30-65
61	85+	46	65+

field conditions. Seed with a cool germination of 30 percent or lower is likely to produce seedlings that emerge slowly and nonuniformly.

The effects of slow, nonuniform seedling emergence can be seen in Tables 4.4 and 4.5. The later the seedlings emerge, the lower the yield.

Seed lots with different seed vigor indices can produce similar lint yields if the final plant population is distributed fairly uniformly. Studies indicate that the primary effect of seed quality on yield is directly related to adequate stand establishment (Tables 4.4 and 4.5).

Other factors also affect seedling emergence (Table 4.6), including soil aeration, soil crusting and ammonia toxicity.

Soil aeration affects the germination process. Planting into very wet conditions affects oxygen uptake, which keeps the oils in the seed from converting to usable sugars and proteins. The sugars and proteins are necessary for new root and shoot growth.

Soil crusting and ammonia toxicity directly affect seedling establishment. Salt can compete with roots for water and desiccate seedlings. To

Table 4.4. Effect of seedling emergence on lint yield.

Seedling Emergence Rate (Days After Planting)	Relative Lint Yield (% of Highest Yield)	Survival Rate (Seedlings Emerged/Seeds Planted)
5	100	87
8	46	70
12	29	30

Source: Wanjura, D. F., 1969. Agronomy Journal, 61: 63-65

Table 4.5. Effect of seed vigor index on seedling emergence rate, stand count and lint yield. College Station, TX. 1986.

Seed Vigor Index	Emergence Rating	Final Stand (%)	Lint Yield (lbs/ac)
133	Good	59	947
132	Medium	62	778
102	Fair	50	772
63	Poor	42	739

avoid salt build-up, place starter fertilizers 2 inches below and 2 inches to the side of the seed.

Other techniques to minimize problems associated with germination and seedling establishment are listed in Table 4.7.

Table 4.6. Factors affecting stand establishment.
Seed hydration
Cold temperatures at planting and emergence
Soil aeration
Soil crusting
Salts and sodium
Ammonia toxicity
Seedling diseases

Table 4.7. Management tools to minimize impact of crust formation
Rotate crops to improve organic matter
Avoid surface compaction
If crusts develop, use the lightest weight equipment possible to break crust and avoid compaction
Avoid deep planting (more than 2 inches)
Use high vigor seed

Plant densities

Plant densities can affect a crop's growth and development. When plant populations are high (more than 60,000 plants per acre):

- Cotton seedlings will grow taller, but average plant height at the end of the season will be shorter because of competition for water, sunlight and nutrients.
- Fruiting branches may be up to 25 percent shorter, causing more fruiting up the plant rather than on the fruiting branches.
- The crop uses more water early in the season than in thin stands because the roots expand more in moist soils and the total leaf area is increased. This is critical in the western portions of the state where moisture is consistently limited.

At lower plant populations (less than 60,000 plants per acre), the crop retains and matures a higher percentage of fruit because more light penetrates into the canopy. The increased light into the lower canopy helps maintain photosynthetic activity in the leaves just below (subtending) the young bolls, thereby increasing fruit retention.

Fortunately, cotton has the unique ability to adapt to a wide range of plant densities. Under favorable growing conditions, uniform plant stands ranging from 30,000 to 60,000 plants per acre will often produce similar yields.

However, under low moisture conditions, higher plant populations (more than 60,000 plants per acre) can delay the onset of the first fruiting branch. Growers using Ultra Narrow Row (UNR) systems (row widths of less than 20 inches) should strive for plant densities of 80,000 to 100,000 plants per acre.

Low populations (less than 30,000 plants per acre) and high populations (more than 60,000 plants per acre) have their own sets of management problems. Thin stands need to be managed to encourage rapid plant growth and development. You may need to apply growth regulators to reduce the height of the crop and make stripper harvest more efficient.

On the other hand, thick stands may cause shading of the lower leaves, which reduces bloom and boll set. You may need to apply growth regulators to reduce the height of the crop to enable more light to penetrate to lower leaves.

Plant spacing

The key factor in determining optimum plant performance is a uniform plant distribution. If plants are spaced uniformly (seedlings 3 to 4 inches apart down the row in 38-inch rows), each plant has similar opportunities for obtaining light, water and nutrients for growth.

Low-density stands with skips often yield less and mature later, because the plants require time to compensate for the conditions that caused the thin, skippy stand. Bolls must mature later, under unfavorable weather conditions.

A good rule of thumb is that if a minimum of two plants per foot of row survive and if there are few long skips, the stand is adequate for optimum production. Under good growing conditions, the plants on both sides of a 2- to 3-foot skip can compensate for the missing plants with little or no loss in yield.

Studies conducted in Lubbock confirm the importance of uniform stands. In these tests, the length of the skips varied from 6 inches to 9 feet. The skips were placed randomly within the rows to approximate typical field conditions (that is, skips of varying lengths scattered throughout the field). Stands reduced by 25 and 50 percent lowered lint yields by 13 and 26 percent respectively (Table 4.8). A similar pattern was found in a study of irrigated cotton in the High Plains (Figure 4.1).

Planting dates

Cotton can overcome many stresses if it has adequate soil and air temperatures for plant growth. However, growers in most areas of Texas plant before the onset of optimum conditions. Moisture conditions are better early in the season; growers in the eastern part of the state want to avoid late season harvest problems; and in the High Plains, producers want to use as much of the growing season as possible.

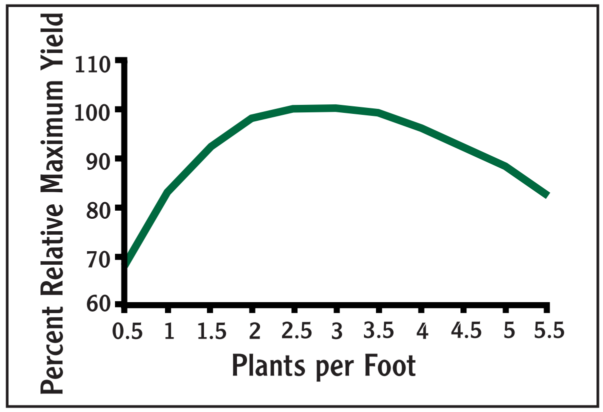

Figure 4.1. Cotton yield/stand relationship for irrigated cotton (40-inch rows) in the Texas High Plains.

Producers should plant according to soil temperature, not the calendar. If planted too early, a crop may suffer stand loss and cold temperature stress, which reduce yield potential. On the other hand, planting too late produces larger plants that are more vegetative and difficult to manage.

The optimum soil temperature for cotton planting is 65 degrees F at seeding depth at 8 a.m. for 3 consecutive days, with a favorable 5-day weather forecast. Temperatures of 60 degrees F are acceptable with a favorable forecast.

However, planting in soils cooler than 55 degrees F will cause poor seedling vigor and seedling disease problems. Also, delay planting

Table 4.8. The effects of skippy stands on cotton yields, Lubbock, TX. 1981-1984

Treatment	Average stand (plants per foot)	Lint yield (lbs/acre)	Percent Yield Decrease
Normal stand	4	438	—
25% Stand loss	3	382	12.8
50% Stand loss	2	324	26.0

Source: Texas A&M University Research and Extension Center at Lubbock by Dr. Don Wanjura, Ag Engineer-USDA and James Supak, Extension Agronomist-Cotton.

when the 5-day forecast predicts the accumulation of less than 25 DD 60s.

The only exception to using soil temperatures as the planting date guide is in the Rolling Plains, where producers generally plant later in warmer soils to take advantage of favorable spring and late-summer rainfall patterns.

Factors affecting stand establishment

Stand establishment is affected by soil temperatures, seed-to-soil contact, seed and seedling diseases, and the use of herbicides and insecticides.

Soil temperatures of less than 50 degrees F cause chilling injury to cotton. If this occurs when the seed is absorbing water (imbibition), the seed can die after the root tip has pushed out a half inch. If the seed does survive, the plant may never develop a normal taproot. Chilling temperatures within the first 5 days after planting often result in weak plants, delayed maturity and reduced yield.

Good seed-to-soil contact is also critical to uniform stand establishment. One key to good seed-to-soil contact is a properly functioning press wheel that is properly aligned and suspended, free-rolling and clean.

You can overcome many problems associated with seed-to-soil contact when using a disc-opening type planter by modifying the press wheels. Adaptations such as having one press wheel with a smooth surface and the other with a spiked surface can improve seed-to-soil contact and reduce potential crusting.

Seed and seedling diseases: The seedling disease complex is the primary disease problem of cotton in Texas, causing from 3 to 9 percent damage, depending on growing conditions (Table 4.9). Losses in individual fields range from zero, where surviving plants can compensate for the lost yield of a few dead seedlings, to total.

Table 4.9. Environmental factors favoring seed or seedling diseases.

Soil temperature less than 65° F
Cold and wet five day forecast after planting
Cold germination test less than 60%
Field has a history of severe seedling disease problems
Minimum tillage
Cotton not planted into beds
Poorly drained soils

Seedling disease is caused by several species of soil fungi, which may occur separately or in combinations. Stands with seedling disease problems are usually uneven and slow growing, with skips in the rows.

The primary pathogens are *Rhizoctonia solani, Pythium* spp. and *Thielaviopsis basicola*:

- *Rhizoctonia solani* is the most prevalent seedling disease pathogen of cotton. It can also cause disease after seedling emergence. This pathogen causes "sore shin," which is characterized by sunken reddish-brown lesions at or below ground level.
- Infection with *Pythium* is favored if the soil has remained saturated for several days or if it is poorly drained.
- *Thielaviopsis basicola* rots the cortex (outer layer) of the root, turning it black, while leaving the inner vascular tissue white. Even though the pathogen destroys all lateral roots, the plants usually survive. The crop is delayed in maturity as the plants use their resources to form new lateral roots just below ground level. If this occurs, modify your cultural practices to accommodate plants with limited taproots and shallow lateral roots.

Other pathogens include *Fusarium* spp. and *Phoma exigua* (which also causes Ascochyta, or wet weather blight, on above-ground plant parts), which can attack the cotton plant throughout the germination and establishment period.

Other symptoms of seedling disease include seed decay, decay of the seedling before emergence, partial or complete girdling of the emerged seedling stems and seedling root rot. The damaged seedlings that emerge are pale, stunted and sometimes die within a few days. There also may be a soft, watery rot or dark lesions on the stem and root. In severe cases, the taproot is destroyed and only shallow-growing lateral roots remain to support the plant.

Seedling disease caused by *Phoma exigua* is generally spotty within a field, and many plants recover when dry, warmer weather returns. The initial symptoms are small, round, reddish-brown spots with dark brown borders on the leaves. Later, the center of the lesions become ashy in color and may fall out.

Control programs for seed and seedling diseases are based on preventive rather than remedial or rescue treatments. These include using crop rotation, quality seed, timely planting and fungicides.

Most commercially available seed is treated with fungicides. It is sometimes possible to customize the treatment to reflect increased disease pressure and the prevalence of certain pathogens in particular fields. Producers can expect increased disease control as they increase the number of control practices used.

Fungicide seed treatments can be supplemented with planter box treatments or in-furrow applications of liquid or granular fungicides. These additional treatments are necessary if fields are under increased disease pressure, for example, during prolonged periods of cool, wet weather. The advantage of planter box treatments is that the decision to use them can be made the day of planting.

In recent years, planter box treatments have not provided improved disease control over certain combinations of seed-treatment fungicides. In-furrow fungicides require the highest level of input and expense for seedling disease control. In tests on the High Plains, in-furrow treatments have also not outperformed the better seed treatments.

Insecticides and herbicides: Organophosphate granular insecticides can negatively affect stand establishment. When combined with cool, wet weather, insecticides can reduce germination and result in a skippy stand.

Misapplication of soil-applied herbicides can also affect final stands. Plants can be injured by preplant incorporated and preemergence herbicides if applied at improper rates and/or by cool-wet conditions after planting. They can also be affected when herbicide-treated soil splashes onto leaves and into the terminal.

Replant decisions

Because of adverse weather conditions and the inherent weakness of cotton seedlings, producers in Texas must make replant decisions almost every year. In deciding whether to replant, growers should determine whether the crop can be salvaged, calculate the costs of replanting, check the calendar dates and consider the alternatives to replanting.

The first rule to consider in a potential replant situation is not to make a hasty decision. It is very easy to become discouraged and want to start anew. However, it is advisable to delay your final assessment until the crop is exposed to 2 to 3 days of good growing conditions.

During this time, protect the crop from further damage with timely tillage operations if necessary. Tilling crusted fields will minimize wind and sand damage, improve aeration and hasten warming and drying of the soil, which slows the development of seedling diseases.

Evaluation of hail-damaged plants is relatively straightforward, especially if normal growing conditions follow the injury:

- Plants severed below the cotyledon leaves will not survive.

- Plants with deep stem bruises may eventually die or recover only partially.
- Plants that are cut below the terminal but above the cotyledons may survive if viable buds remain on the plant.
- Defoliated plants will survive if the main stem is not badly damaged. The presence of any remaining living plant tissue (whole leaves, portions of damaged leaves) will increase the chances of survival and speed the recovery of plants with intact stems.

Check the condition of the roots each time you evaluate the stand. Use a shovel to dig up plants and evaluate the condition of the taproot. Inspect for hail damage and disease lesions at ground level.

If the taproots have a black, water-soaked appearance, then the disease is still active and further damage will occur. If the taproot is still intact and the outer covering of the root has hardened (though it is discolored), the chances of recovery improve.

Growers should also use a sharp knife to cut the stem lengthwise and check the inner tissue, especially if there is foliar disease damage (leaf spots). Wet weather blight (Ascochyta or *Phoma exigua*) and other disease organisms can invade and eventually plug the water- and photosynthate-conducting vessels within the plant. If weather conditions are forecast to be cool and wet, count only the healthiest plants as potential survivors.

Remember also that replanting has additional costs for seed, labor and machinery use. It may also require additional expense for irrigation, herbicides, insecticides and fungicides.

Other considerations for making replant decisions include crop insurance coverage, farm program options and the yield/price outlook for alternative crops.

Calendar dates also need to be considered. If replanted late, fields in the eastern part of Texas may be hampered by increased insect pressure and poor harvesting conditions. Those in the west will be affected primarily by the shortened season.

Table 4.10 shows the impact of delayed planting dates in Lubbock. Although growers south of Lubbock have greater flexibility, yields will decline dramatically if cotton is planted after June 20, even in the southern portion of the Rolling Plains.

Producers in the eastern part of Texas have more flexibility with lower plant stands because of the extended growing season. As the planting date approaches June 20, producers in West Texas should consider planting short-season varieties.

In evaluating the crop, the main factors to assess are the health of individual plants and the uniformity of the stand (skips less than 6 feet within the row and an adequate stand on rows on either side of the skip). The goal is to achieve a uniform, healthy plant stand.

Table 4.10. Yield reduction of irrigated cotton because of delayed planting at Lubbock, 1960-1966.

Planting Date	Relative Lint Yield (%)	Yield Decrease (%)
May 15	100	–
June 1	93	7
June 10	76	24
June 20	51	49