Crop Management Module

Certified Crop Advisor

State Performance Objectives

General New Mexico Planting Factors Competency Areas:

1. General planting considerations
2. Factors affecting selection of specific crops
3. Seed selection
4. Seeding dates, rates, patterns and depths
5. Crop factors affecting planting, replanting and management decisions

Learning Objectives

The objectives for the New Mexico Crop Management Module are:
· To be able to assess seed needs and general factors affecting planting
· To learn more on seeding date, rate, depth and patterns in crops
· To review factors that optimize crop planting and limit replanting needs
· How to manage agronomic and economic information to improve crops

Pre-Study Questions for Review

1. Seed in storage is affected by?
    a. wind, water and trash in the seed mix
    b. temperature, humidity and length of time stored
    c. light, wind and how high the seed bags are stacked
    d. temperature, trash and wind
2. Certain seed tests will help in evaluating seed condition. Three of these seed tests that are commonly used include?
    a. the Holly test, the warm water test and the tetrazolium test
    b. the age test, the tetrazolium test and the Holly test
    c. the seed coat thickness test, the age test and the warm water test
    d. the warm germination test, the cold test and the tetrazolium test
3. Pure live seed is?
    a. the actual size of the seed lot
    b. the actual germination percentage of the seed lot
    c. the actual seedling numbers
    d. the actual number of seed of a specific crop
4. Some of the factors that would have to be considered before deciding to replant include?
    a. seed size, cost of the operation and soil conditions
    b. degree of crop injury, potential for alternative crops and seed size
    c. value of the crop, time of year relative to the growing season and seed depth
    d. value of the crop, the ability of the crop to recover and degree of crop injury
5. Hard seed is a term used to describe what?
    a. seed that cannot respire properly
    b. seed that has a hard seed coat that is impervious to water
    c. seed that is shaped unusually and thus is difficult to plant
    d. seed that is so small it is hard to see

Check your answers before proceeding into the unit to find out how much you already know about the basic concepts on planting factors. Each correct answer is worth 20 points, based on a total of 100 points for the five questions. Answers: 1. b.; 2. d.; 3. b.; 4. d.; 5. b.

General planting considerations

Seeds and their establishment are the primary beginnings to effective crop development. The seed is not only the living link for genetics but also the primary means of dissemination and thus must survive environmental conditions that will still allow favorable germination and growth. Biologically the seed is the ripe, fertilized ovule of a species. Germination is the resumption of active growth that results in the rupture of the seed coat and the emergence of the seedling. Germination involves many physiological and morphological processes in order to successfully be initiated. Seed must successfully imbibe and absorb water, hydrate tissues in the seed, initiate absorption of oxygen, activate enzymes and digestion, transport hydrolyzed molecules to the embryo axis, increase respiration and assimilation, initiate cell division and enlargement as well as promote embryo emergence. And, these processes can be affected further by seed depth of planting, seed size, seedbed texture, fertilization practices, moisture availability and date of planting to just mention a few influencing factors. Because all of these external and internal factors can influence germination not to mention seedling vigor and seed viability, any crop management practices that can limit adverse conditions to the seed and seedling will benefit crop establishment and ultimate yield. Indeed, some of the mechanical factors that can be influenced by the farmer include: depth of planting, seedbed texture, fertilization practices and date of planting. Choice of hybrid or variety and timing of planting within a time frame when environmental conditions encourage successful seed germination and seedling establishment are also important to consider.

The progressive development of a plant from a seed is usually expressed as dry weight, height or diameter. In general germination progresses in a sigmoid curve type pattern. That is, as the seedling emerges and grows over time the total growth increases to a point where maximum growth rate is achieved and then growth continues but slows in rate until maturity or the end of the life cycle. Some suggest that over fifty factors can influence plant development of which farmers can possibly use practices and timing to modify about two-thirds of these effects.

Having already discussed soils and nutrients for specific crops, soils can affect seed germination and seedling growth through soil fertility levels, soil pH, soil drainage, or even specific conditions such as saline or sodic soil condition. Once the seed germinates, seedlings respond to balanced nutrients for each specific crop. Ultimate crop yields may be influenced by soil fertility because of the type of crop, soil series, level of soil fertility, type of fertilizer used, cropping system and the tillage system. The crop may also be influenced by soil fertilizer applied due to economics of the value of the crop, expense of the fertilizer and the value of the environmental impacts from fertilization.

Soil pH can affect the balance as well as the availability of nutrients. Soils too acid or too alkaline may also affect plant growth due to affects on the plant root cells that might influence the permeability and even the uptake of water or nutrients by the roots. Certain crops grow better within a limited pH range. Listed below are some of the soil reaction (pH) preferences of several crops currently or previously grown in New Mexico.

General Soil pH Crop Preferences

Crop	Minimum pH Limit	pH range preferred	Maximum pH LImit
Alfalfa	5.5	6.2-7.8	8.5
Beans (dry)	5.0	6.0-7.5	--
Beets (sugar)	5.5	6.5-8.0	8.5
Cabbage	--	6.0-7.5	--
Cantaloupe	5.5	6.0-7.5	--
Carrot (garden)	5.0	5.5-7.0	--
Celery	--	5.8-7.0	--
Clover	--	5.0-6.0	--

Corn (Indian)	5.0	5.5-7.5	--
Corn (pop)	--	6.0-7.5	--
Corn (sweet/field)	5.0	5.5-7.5	--
Cotton	--	5.0-6.0	--
Cowpea	4.5	5.0-6.5	7.0
Egg plant	--	5.5-6.5	6.0
Grass (Bermuda)	--	6.0-7.0	--
Grass (buffalo)	--	6.0-7.5	--
Grass (orchard)	5.5	6.0-7.0	8.0
Grass (pampas)	--	6.0-8.0	--
Grass (perennial rye)	5.0	6.0-7.0	8.0
Grass (Timothy)	--	5.5-8.0	--
Kohl-rabi	--	6.0-7.5	--
Lettuce	5.5	6.0-7.0	8.0
Oats	4.5	5.0-7.5	--
Pea (field)	5.5	6.0-7.5	--
Peanut	--	5.3-6.6	--
Pecan	--	6.4-8.0	--
Pepper (sweet)	--	5.5-7.0	--
Radish	5.0	6.0-7.0	--
Rye	4.5	5.0-7.0	8.0
Soybean	5.5	6.0-7.0	--
Sunflower	--	6.0-7.5	--
Vetch (hairy)	4.5	5.2-7.0	--
Wheat	5.0	5.5-7.5	--

Some of the maximum pH limits are set for disease control.

Source: Spurway, C.H. 1941. Soil reaction (pH) preferences of plants. Spec. Bull. 306, Michigan State College, East Lansing, MI.

Other Crop Factors that Affect Selection

Besides soil pH many other factors affect crop selection on a field. Soil fertility levels may be another factor affecting crop selection. Depending on the level of the soil test and previous crops grown within the rotation, a farmer may make decisions on crop selection based on available fertilizer for a particular crop. Different crops not only respond differently to varying levels of nutrients but also may exhibit slight variety differences in growth response curves to nutrients in the soil. Depending on the nutrient, the plant may utilize the mineral at different times during the plant's life and in varying amounts. This relationship between soil fertility and plant growth is most noticeable when one element is limiting in the plant's nutrition. If the limiting nutrient is supplied, the plant growth will increase but the growth will be progressively smaller with each successive addition once the basic need is supplied. This principle of limiting factors is generally stated as the level of crop production can be no greater than that allowed by the most limiting of the essential plant growth factors. This principle is true not only with nutrient supplies but on all other factors that may also affect plant growth. Indeed, other factors that may influence crop selection include also the type of crop; soil series; level of soil fertility; type of fertilizer purchased to use; cropping system; and, tillage system. When these factors have the crop economics included, you must also remember that the value of the crop, the expense of the fertilizer, and the value of the environmental impacts of fertilization also work into the equation for crop selection on a field. Even physical factors of the field may influence cropping choice. Size of the field, orientation of the field, soil texture, soil drainage, availability of irrigation and accessibility to the crop market or elevator may each influence choice of crop. Soil drainage alone can determine soil compaction from tillage, soil temperatures at critical germination and emergence timings, yield potential, root development, nutrient uptake, availability of nutrients, soil microbe activity, disease potential and crop protection chemical usefulness.

Seed Selection

Seed selection is one of the most valuable inputs controlled by the farmer. Although the initial cost, especially on crops like alfalfa, may appear high, seed cost is one of the less expensive, controllable inputs. For this reason, careful selection of good germ, hardy seedling strength, genetics that allow protection from pests or climatic elements and even adequate food reserves within the seed are important for successful stand establishment and yield. Choice of the hybrid or cultivar will determine the inheritable traits in seed. Hybrids, seed developed from two parents with one or more inheritable traits, will not reproduce all the parent's traits in new seed offspring. A cultivar, on the other hand, will reproduce all of its inherited traits and often is self-pollinating. An example of cultivar crops are cotton and soybeans. In either crop, public seed produced from the crop can be replanted and will produce a crop with the same genetics as the previous crop. Corn, however, is a hybrid and cross-pollinates. Seed from a hybrid when planted will exhibit diverse traits across its offspring, including possibly undesirable inbred traits that may limit growth and yield characteristics. When choosing seed some of the things to consider include: the type of crop, uses, potential yield, value, tillage and cropping management system that will maximize returns, environmental conditions within the field, crop response to the growing season and timing with particular attention to those conditions at planting and early emergence, crop potential from recovery from seasonal conditions and tolerance to cropping management schemes including pesticide use and pests.

Seed quality can affect stand establishment and ultimate yield. A seed purchaser wants to obtain seed that has high germination percentages, freedom from weeds (especially primary and secondary noxious) and other foreign material. Although seed laws vary from state to state, most require much of this information to be available on the seed bag. Usually, the germination percentage from within the last nine months is required, the purity listed as a percentage weight that is crop seed is required (known as pure live seed), the seed lot will show that no primary noxious weed seed are included, any secondary noxious weeds (number and kind) are usually listed and also required is that not more than a certain percentage of the total weight in the bag can be weed seed. Indeed, a purity test will separate the material in the bag on a weight basis for crop seed, weed seed, and noxious weed seed. The pure live seed is simply the percent of pure seed multiplied by the germination percentage of that seed. Knowing the pure live seed will allow a farmer to determine how much seed to buy based on his expected seeding rate. The seed needed to be purchased will be the seeding rate (expected seedling stand) divided by the percent pure live seed (percent of the crop seed that germinates).

Other tests such as germination tests measure the pure seed using standardized tests. This may include a warm germination test, also called a normal germination test, to determine the percentage of crop seed that will germinate when placed in a warm germination environment. Because early seed germination may not have optimum conditions, you may also want to review the cold seed test. The cold germination test, also known as the stress germination test, will subject sample seed from the seed lot to germination conditions in a cold environment (seed, such as corn, is held at 50F for 7 days, then transferred to a warmer temperature to complete germination). This test will determine how well seed withstand disease under cooler, wet soil conditions. A third commonly used test is the tetrazolium test. This test is a measure of the respiration rate of the seed, thus measuring the viability of the seed. Also, simple varietal purity is an important consideration when buying seed, particularly if the seed is from a source that may have mixed varieties or older cleaning equipment.

Seed size is generally correlated to seedling weight with the heaviest seed within a seed lot often producing the most vigorous seedlings. Some tests have shown a positive correlation between yield and larger seed size; however, many agronomic characteristics do not differ with seed size. In some cases, smaller seed, if food supply within the seed was adequate to get the seedling emerged, did not vary in final yield so seed size does not insure better germination unless seed food supplies (seed density) are stretched to the limit in small seed. And, with some crops such as sorghum, early performance is more influenced by seed density than by seed size. Over much of the agronomic data, little is gained by choosing large seed within a variety over small seed unless adverse conditions tap out the food resources in small seed versus larger seed that may have more energy stored to promote the germination and emergence process under adverse conditions.

On some seed, such as alfalfa, the seed may also need to be tested for hard seed, or those seed that have a hard seed coat that may be impervious to water until scratched or decayed so that water penetration and seed germination can proceed. Some seed contains an inhibitor that stops germination until time or conditions allow germination to proceed. This “dormancy” allows seed to not start into the germination process until the seed is placed in an environment that is adequate for the germination process to start and proceed. Water, nonrestrictive temperatures and a suitable atmosphere (germination requires high levels of oxygen unless the respiration associated with it is by fermentation; light is required by many species for germination; and, some external chemicals in the seed environment may provide a role in promoting germination as stimulators) are required for the germination of nondormant, or after-ripened, seed. There are several types of dormancy that can occur in seed. Seed dormancies include: immature embryo; impermeable seed coats; mechanically resistant seed coats; and, physiological (seed that contain growth inhibitors, store growth promoters in such a way they are not readily activated, or the seed have hulls are insufficient to initiate germination—partial seed). Even in a favorable environment, germination will only occur after the seed is mature, or a minimum level of morphogenesis has occurred in the seed. Seed dormancy can increase with seed maturity in certain species. Conditions favoring growth of seedlings also favor germination.

In unusual situations, seed may need to be vernalized in order for the plants to produce seed heads. For example, winter wheat sown in the spring will fail to head unless the sprouting seed or growing plants are subjected to cool conditions. Winter annual legumes and grasses may respond similarly and may have to also be treated with cold temperatures on seed that is around 50 percent moisture content in order cause the plants to later seed. This vernalization process is so labor intensive and complicated that it is rarely used except in certain experiments. And, even with the treatment, vernalized spring-sown winter grain yields much less than when sown in the autumn.

Viability of the seed or seed longevity depends on genotype, dormancy mechanisms and the storage environment. Generally, more favorable storage conditions include: low temperature, low humidity and low oxygen. A general rule is that the sum of the ambient humidity (percentage) and the temperature (F) should not exceed 100 when seed are stored.

As genetic purity is difficult to test, seed certification programs are used to maintain seed of genetic background. Through crop improvement associations, a four-step classification system for certified seed has been established. This system includes: breeder’s seed (controlled by the plant breeder or institute which provides the source of the pedigreed stock); foundation seed (progeny of the breeder’s seed and used for the production of either registered or certified seed); registered seed (progeny of breeder’s or foundation seed and often planted by a select group of farmers who are certified seed producers); and, certified seed (from breeder’s, foundation or most commonly registered seed and is purchased to produce commercial grain or forage).

Seeding Dates, Rates, Patterns and Depths

Stand establishment requires quality seed of an adapted variety, uniform seed distribution and placement, firm seed-soil contact, and appropriate competition (or lack of too much competition) from other plants. It also requires that the crop be planted at an appropriate date, rate, pattern and depth.

The date of planting for crops depends on environmental and cultural factors. Some of the environmental factors that influence seedling development include: the last date of killing frosts in the spring and the first date of a killing frost in the fall; soil temperature; soil moisture at the seed depth; and, the average length of the growing season for each particular crop. All of these factors will influence the seed germination and seedling emergence. Seed are also affected by such cultural factors as: the tillage and cropping system used; the vigor and maturity of the seed planted; pest free dates so that seed can escape pest pressures at emergence; and, the availability of labor and time within that optimum planting period at will allow a crop to emerge, grow and mature within the seasonal constraints.

Crops are generally seeded within a time frame that will permit maximum growth and development toward maturity but before the advent of hot weather, drought or diseases. All plants, whether cool season or warm season, benefit from seeding that avoids adverse conditions during the plant stages when conditions can most limit yield. In all plants, detrimental environmental conditions should be avoided at flowering and into seed fill and also at the prime stand establishment period when seed germinate and seedlings emerge.

Dates of Planting for Several of the Agronomic Crops Grown in New Mexico

Crop	General Period for New Mexico Planting
Corn (Maize)	April 5-May 10
Sorghum (grain, forage)	April 20-May 20, although for forage later dates of planting may occur especially in southern New Mexico and when used as a green manure crop
Winter wheat (triticale, oats, other small grains)	August 25-November 15 (spring oats, February 10-March 15)
Alfalfa	September 25-October 31 with irrigation (dryland stands, August 25-April 15)
Soybeans	April 20-May 15
Dry beans	April 20-May 15
Peanuts	March 1-March 15
Cotton	April 10-April 21

With most crops, delays in planting after the optimum planting period result in decreased yields. Crop plants need time to build up an optimum plant system (vegetative growth that will allow maximum light interception) and then still have time for the system to conduct photosynthesis and produce dry matter (plant leaves) and grain yield. Thus, early dates of planting generally give higher production as long as pertinent pests are avoided and other cropping factors being equal.

Seeding Rates and Patterns

Planting rates (number of plants per unit land area) and the distribution of the plants (arrangement of the plants within the land area) are important in determining crop yield. The objective in spacing crop plants is to maximize yield on a unit area without sacrificing crop quality. Like seeding date, seeding rates are influenced by both environmental and cultural factors. Some of the environmental factors that influence planting rates include: soil temperature, available soil moisture, soil type and even soil fertility levels. Cultural factors affecting planting rates and patterns include: the tillage and cropping system used; your yield goals; crop value; seed quality; crop ability to compensate for stand losses; time of planting as related to the season or normal planting time; and the type of planter and row spacing being used on the farm. The cropping pattern for planting may also be influenced further by the field size and shape, row spacing being used, crop growth form, cultivation needs and later fertility application needs and requirements within the crop and equipment constraints.

Generally, there is a rather definite limit for various regions of the country beyond which heavier seeding rates fail to produce increased crop yields. Heavy seeding seldom reduces yield rapidly even under conditions in the Southwest. Rather, only small decreases from optimum yields were related to high seeding populations while soil type, moisture, locality, date of seeding, cultural treatment and variety had more effect on reducing yields than actual seed rates. High seeding rates in small grains simply result in less tillering. Thin seeding of hard winter wheat is common in drier climates in the South and is feasible because heavy tillering can make up for the thin stands. Likewise with millets, free-tillering varieties can also have thin stands compensated by an increase in number of tillers. In cotton, high seeding rates will simply have the closely spaced plants complete their fruiting earlier than widely spaced ones. Even in irrigated corn, plant populations from 30,000 to 36,000 have been shown to have less than a five percent loss even in such tight stand populations.

More specifically, some of the factors affecting planting rate as well as distribution (or planting pattern) include: percent germination and percent purity of the seedlot; competitive ability of the plant (ability of the plant to utilize space) which may include plant size, canopy characteristics and tillering/branching tendencies as well as competitive ability of plants grown in mixtures of species or varieties as with mixed forages; soil type; planting date; and, climate. In recent years, interest in narrow-row crops has received considerable attention. In some cases, crops that may genetically have a plant architecture that allows a smaller space to still allow sunlight use and optimization will benefit when planted in narrower rows than previously suggested by research. However, soil moisture availability and length of season may also influence if narrow rows are a better management strategy. In general, narrower rows benefit some crops, especially as one farms further north and east within the United States. As one travels north, the season length is less and crop plants are generally shorter and as one travels east, more precipitation allows farmers to be able to plant more seed per acre within narrower confines without drought stress occurring. Exceptions to this general rule exist, particularly as short-season, shorter-stature plants are used in the south and can be more closely planted together on irrigated land. Also, mixed crops such as companion crops or relay crops may set limitations on planting rates and plant spacing within a field.

Seeding depth is also an important consideration in crop production planning. Generally, the larger the seed, the deeper it can be planted and still emerge from a soil. Seeds will emerge from greater depths in sandy soils than in clay soils and in warm soil than in cold soils. It is common in small grains to plant seed to moisture or to “dust it in” to compensate for variable moisture found in drier regions. And, with grass crops, as long as depth is not so deep that seed reserves play out before the growing point can emerge and begin photosynthesizing energy or as long as the species does not require light to activate germination, depth of planting can be varied somewhat with stand establishment success. However, on broadleaf crops, depth of planting may need to be more carefully monitored. Due to the emergence pattern of broadleaves, genetic limitations on extension of the hypocotyls may play a role in limiting depth of planting. Also, under heavier soil (clay) situations broadleaf crops can come under more constraints in emerging from soil due to crusting problems. Depth of planting is also an important factor determining the seedling emergence of many grasses and small-seeded legumes that may contain very limited amounts of food reserves.

Relationship between Seed Size and Preferred Planting Depth

Crop	Type	Seed Size (number/lb.)	Preferred Planting Depth (in.)
Alfalfa	broadleaf	200,000	0.50
Wheat	grass	15,000	1.50
Oats	grass	14,000	1.50
Soybeans	broadleaf	2,500	1.50
Corn	grass	1,200	2.00
Red clover	broadleaf	250,000	0.50
Cotton	broadleaf	5,000	2.00
Sorghum	grass	14,500	1.50

Chile pepper	broadleaf	72,000	0.50

Some conditions in the field may exist that require a change in seeding depth. Although planting should be optimize with as few poor seeding conditions existing as possible, situations such as available soil moisture (too low or too high), degree of seed-soil contact, placement of herbicides, or soil temperature may require some adjustment of seeding depth.

Temperature Ranges to Optimize Germination on Three Grass Crops

	Temperatures (F)		
Crop	Minimum	Optimum	Maximum
Corn	46-50	90-95	104-111
Wheat	37-41	59-88	86-109
Oat	37-41	77-88	86-104

Source: from Mayer and Poljakoff-Mayber 1963. The germination of seeds. New York: Macmillan.

Crop Factors Affecting Planting, Replanting and Management Decisions

The factors determining seeding rates also affect planting and replanting decisions. These factors include environmental factors (available moisture, soil temperature, soil type, and soil fertility levels) and cultural factors (tillage/cropping system, yield goals/value of the crop, quality of the seed, yield compensation ability, time of planting relative to normal planting times, as well as the type of planter and row spacing used). Even within these factors seedbed texture and moisture relationships can also influence planting or replanting options. The soil particles within the seedbed should be large enough to minimize crusting and to maximize aeration which can then promote favorable soil temperatures but small enough to get good seed-soil contact. Seed-soil contact is important to promote rapid water imbibition. Especially on small seeds, press wheels behind the planter box can help promote good seed-soil contact so that the seed can rapidly absorb moisture and begin the germination process. Furrow-openers are also often used in front of press wheels on a planter so that seed can be placed directly into moist soil and then covered and soil pressed on the seed for accurate seed depth and good seed-soil contact to optimize germination.

All crops contain characteristics that may or may not allow them to be more adaptable to high or low seeding rates. Besides the environmental and cultural factors mentioned above, the crops also may be influenced by their efficiency in water use and nutrient uptake. Some crops, such as soybeans or other legumes, may be able to compensate for low nitrogen levels in soils by fixing nitrogen through their nodulation system. However, these same legume plants when faced with more than ample supplies of nitrogen may be “lazy” and simply use nitrogen from the ample supplies rather than even developing a nodulation system. Thus, if supplies become limited later in the season due to losses from volatilization or leaching, the plant may not be able to compensate for the low nitrogen supply. On the other hand, hail losses in soybeans can sometimes be compensated by late-vegetative branching on the plants. The tillering ability in winter wheat is another example of a crop that may be able to compensate for low seeding rates if other seasonal constraints are not limiting. This ability to compensate for changes in plant population as well as any crop adaptation to water use efficiencies allow crops to adapt to high or low seeding rates and are related not only to variety characteristics (species), but can even be affected by the hybrid characteristics (specific genetic traits) of a plant.

Several climate and plant factors may exist that will influence replanting decisions. These include: age of the plant, damage in relation to the growing point(s) on the plant, the amount of soil moisture, the soil fertility, the probability that disease could invade existing, damaged plants or even new seedlings, and the genetic factors of the plant. In order to assess whether a field should be replanted, the economics, time of season and the above cropping factors must all be taken into account. In fact, consider the following six questions when deciding if replanting is an option:

1. What is the value of the crop (existing versus replanted), especially if contracted?
2. What is the time of year relative to the needed growing season for the crop?
3. Does this crop have the ability (and is in the condition) to recover from injury seen across the field?
4. What is the value of the crop currently (before replanting) and the degree of crop injury?
5. Is there a potential for the use of alternative crops on the field at this point in time?
6. Have any pesticide (herbicide, insecticide or fungicide) treatments or fertility levels been applied to the field that will limit replanting or even the use of alternative crops?

Specific crops will often also have research that has been run that can help in determining plant population or injury condition ranges that can be used along with date of planting to help in determining if replanting will be worth the added costs and risks as compared to keeping a poorer crop stand. Also, any possible pest problems that can occur during the rest of the cropping cycle must be considered. Looking at the economic risk assessment on a field can help evaluate planting and replanting as well as management needs.

Because weather conditions have been analyzed and generalized dates of planting determined for crops within a region, row-crop production has often been "calendarized." This planting system allows the farmer to plant within a set time period so that he may harvest within an estimated period. This method can work in all years except those that end up being "exceptional" years. Calendarization is a system that may be used to help in planning or scheduling planting, cultivation, applications and even harvesting but must continue to be monitored and revised based on climate and genetic differences that occur each year. The system can help in increasing efficiency, particularly if you have problems in peak labor loads during seedbed preparation, planting or even harvesting. However, using the calendar system without adjusting for climate and field conditions changes as well as for genetic differences for new hybrids or varieties during the year can cause operations to be scheduled in less than optimum times. Some of the most common problems that can disrupt the use of calendarization include: unfavorable weather, pile-up of work loads, high grain moisture conditions and late harvests.

A more definite scheduling system that can be used rather than calendarization is the use of growing-degree-days or heat units. Use of actual heating units correspond more closely with optimum timing of field operations and also adjust operation scheduling along with any climate changes. Knowing the seasonal growing-degree-days for specific hybrids and varieties also allows you to pin-point maturity dates more accurately so that end of the season operations can be scheduled with more precision. Use of growing-degree days also can make planting operations optimize the seed placement into soil that is better for germination of the specific crop. Use of growing-degree-days can also allow the farm manager to scout for probable pests with greater accuracy as many insects (their detrimental stages), diseases (their climatic ranges) and even weeds (their germination and emergence times) also are more prevalent within certain heat unit ranges. Over time, use of the growing-degree-day system is much more accurate and helpful to the farmer than scheduling operations based on the calendar.

Post-Study Questions for Review

1. One set of factors that affect seeding rate is environmental change. All of the following but one is an environmental factor. That one that is not is?
   a. soil temperature
   b. soil texture
   c. soil moisture availability

d. crop compensation on yield

2. In seed breeding, cross-fertilization of two lines (two varieties or two species) results in what type of progeny?
   a. hybrid
   b. backcross
   c. criss-cross
   d. new inbred
3. Plant growth is usually expressed graphically as a _____ curve.
   a. Freud
   b. Circular
   c. Contrasting
   d. Sigmoid
4. Soil pH can affect the balance as well as the _____ of nutrients.
   a. storage
   b. availability
   c. activity
   d. number
5. Factors that may influence crop selection include the type of crop; soil series; _____ ; type of fertilizer purchased to use; cropping system; and, tillage system.
   a. level of plant life
   b. level of crop condition
   c. level of microbial activity
   d. level of soil fertility
6. The principle of limiting factors is generally stated as: the level of crop production can be no greater than that allowed by the most limiting of the _____ plant growth factors.
   a. essential
   b. trace
   c. secondary
   d. primary
7. Although the initial cost, especially on crops like alfalfa, may appear high, _____ is one of the less expensive, controllable inputs.
   a. herbicide costs
   b. tillage costs
   c. seed costs
   d. fertilizer costs
8. A _____ , on the other hand, will reproduce all of its inherited traits and often is self-pollinating.
   a. hybrid
   b. cultivar
   c. seed sample
   d. inbred
9. In unusual situations, seed may need to be ______ in order for the plants to produce seed heads.
   a. hybridized
   b. inbred
   c. sanitized
   d. vernalized
10. Stand establishment requires quality seed of an adapted variety, uniform seed distribution and placement, firm _____ , and appropriate competition (or lack of too much competition) from other plants.
    a. seed-soil contact
    b. clod formation
    c. seed coat
    d. water table level

Check your answers before proceeding into the unit to find out how much you already know about the basic concepts on planting factors. Each correct answer is worth 10 points, based on a total of 100 points for the ten questions. Answers: 1. d.; 2. a.; 3. d.; 4. b.; 5. d.; 6. a.; 7. c.; 8. b.; 9. d.; 10. a.