A Survey of Factors Involved in Crop Maturity

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ABSTRACT
The time necessary for crops to successfully complete reproduction is species and environment dependent. Lifecycles can be completed in a few weeks or take several years depending on the plant species. Crop development is divided into phenophases that are affected primarily by light and temperature changes, interacting with phytohormones. Some species are influenced more by light and others by temperature. This review focuses on factors that influence maturation in several important agronomic crops.

LIFECYCLE DURATION of all agricultural crops is important to their management for maximum economic yield. Humankind has, and in many parts of the world, continues to schedule their life’s activities around the planting and harvesting of food, feed, and fiber. Ancient cultures in Mesoamerica developed elaborate and accurate solar calendars to assist in the production of crops necessary for their survival and celebrated successful harvests with certain rites and rituals. Even today in the United States and Canada a national holiday of Thanksgiving, with origins in a successful year of agricultural production, is observed each autumn.

Unlike most animals, whose organs are determined prenatal in the embryo, plants respond to environmental conditions at certain periods of growth, undergo transformations throughout their lifecycles, and form new organs from primordia developed from meristems. The ultimate goal of flowering plants, as with any life form, is to reproduce. Depending on a specie’s area of adaptation the period of time necessary to successfully complete reproduction can be as short as a few weeks to as long as several years.

Most agronomic crops have had their growth and development classified into distinct phases or stages. Each of these stages is referred to as a phenostage and signals a change in the crop’s development (Loomis and Connor, 1998, p. 105). The study of phenology examines the developmental rate of a crop and the amount of time between the various phenostages. Most all descriptions of growth stages in crops will include maturation, vegetative growth, flowering and/or reproductive growth, and maturation. Artzca (1996, p. 165) describes maturation as qualitative changes that allow a plant or organ to express its full reproductive potential. Maturity in virtually all crops can be divided into two types, physiological maturity which describes that period when sexually induced reproductive growth has ceased, and harvest maturity, where the seed, fruit, or other economically important organ of yield has reached a state of “ripeness” and can be removed from the parent plant for consumption. For most agronomic crops maturity ratings refer to the time from germination until physiological maturity. Days to harvest maturity can be different from one season to the next for the same cultivar and is greatly influenced by environmental conditions, especially temperature; relative humidity; and extent of cloud cover after physiological maturity.

The American Society of Agronomy, Crop Science Society of America, and the Soil Science Society of America list several suggested references for identifying various phenostages of agronomic crops commonly grown in the western hemisphere (ASA, CSSA, and SSSA, 1998, p. 45). Most published descriptions can be readily used by both researchers and producers while some are more applicable to one group than the other. Ritchie et al.’s (1997) description of corn (Zea mays L.) growth and development and Ritchie et al.’s (1994) enhancement of Fehr and Caviness’s (1977) description of soybean (Glycine max L. Merr.) phenostages are readily used by both the research community and growers. With small grains Tottman’s (1987) enhancement of Zadoks et al.’s (1974) scale is frequently quoted by researchers while Bruns and Croy’s (1983) description of winter wheat (Triticum aestivum L.) growth and development is more readily applicable to producers.

The appearance of reproductive phenophases in plants has come about through the evolution of mechanisms that assure its maturation during times of favorable environmental conditions. Daylength, temperature, and their interaction with various phytohormones are all vital in the appearance of the various phenophases. Still other plant species are highly dependent on exposure to water, light, and/or scarification before beginning their lifecycle. Available water and plant nutrition, particularly N have been shown to have effects on reproductive phenophases but not to the extent of light and temperature.

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Abbreviations: DNIP, day-neutral plant; GDD, growing degree day; GDU, growing degree unit; LDP, long-day plant; MG, maturity group; Pfr, phytochrome far-red; Pp, phytochrome red; SDFP, short-day plant.
Water deficits have been shown to delay development of floral primordia in both grain sorghum [\textit{Sorghum bicolor} (L.) Moench] and barley (\textit{Hordeum vulgare} L.) (Dennis, 1984). By contrast, applying even slight excesses of N fertilizer to cotton (\textit{Gossypium hirsutum} L.) past peak bloom can result in promoting vegetative growth and delay maturity (Silvertooth, 1999). Pettigrew (2003) also found that low levels of K fertility in cotton resulted in a brief enhancement of early season flowering and premature termination of reproductive growth.

Regardless of species, all flowering plants go through a juvenile or vegetative phase before achieving sufficient development to initiate reproductive growth. This period may be as short as 96 to 120 h, as with lambsquarters (\textit{Chenopodium album} L.), or 5 or more years as is the case with many fruit and nut trees (Dennis, 1984). In studying photoperiod sensitivity in crop plants both Vergara and Chang (1976) and later Major (1980) concluded that a required basic vegetative phase was necessary before photo-induced reproductive growth could begin.

The influence of daylength on plant development has been extensively studied, and virtually all crop plants as well as many weed species have been classified according to their response to light and the initiation of reproductive growth. In reality it is both the change in exposure to periods of light and darkness that trigger the mechanisms and results in the classification of plants as short-day (SDP), long-day (LDP), or day-neutral (DNP) with respect to their transformation from vegetative to reproductive growth (Dennis, 1984).

Short-day plants are induced to flower with a lengthening of the dark period. This was one of the first photoperiodic responses identified and extensively studied (Garner and Allard, 1920). Long-day plants react in the opposite, being induced to flower with the shortening of the dark period while day-neutral species appear to be unaffected by changes in photoperiod with respect to entering their reproductive phases. In broad general terms, plants that evolved in tropical environments are SDP with no vernalization (exposure to cold temperature) requirement while plants that evolved in the higher latitudes are LDP, often with a vernalization requirement (Loomis and Connor, 1998, p. 105). Day-neutral plants can be found in both tropical and temperate climates.

Light energy of the red (600–680 nm) and far-red (720–750 nm) portion of the spectrum is the force that affects plants’ photoperiod response. A blue-green chromoprotein known as phytochrome, which is found in two principal forms, is responsible for absorption of this light energy (Quail, 1976). The red absorbing form identified as Pr is considered biologically inactive while the far-red absorbing form identified as Pfr is responsible for inducing biological responses. Both of these chromoproteins are reversibly interconvertable by exposure to red and far-red light. With respect to flowering, the Pr-to-Pfr ratio in a plant is likely more important than quantities of either chromoprotein. The amount of light exposure necessary to induce reproductive growth varies with species (Dennis, 1984). Extensive discussions of the physiology of photoperiodism are available in several texts.

Temperature appears to have an equally important role in inducing reproductive growth in several crops. Winter annual cereals such as wheat, barley, oat (\textit{Avena sativa} L.), and rye (\textit{Secale cereale} L.), most biennials, and temperate perennial species have a vernalization requirement necessary to initiate reproductive growth. Most winter cereals initiate reproductive growth after exposure to near 0°C temperatures for 14 to 63 d, followed by increases in both temperature and photoperiod. Without increasing temperatures, winter cereals will not begin growth even though vernalization has been completed and the photoperiod is lengthening. Along with initiation of reproductive growth, winter annual species rapidly lose freeze tolerance that sustained them during their exposure to cold temperatures (Levitt, 1980, p. 150). Cool-season perennial forage grasses such as timothy (\textit{Phleum pretense} L.), orchardgrass (\textit{Dactylis glomerata} L.), tall fescue (\textit{Festuca elatior} L.), and several turfgrass species will not begin extensive reproductive growth until temperatures have warmed measurably in the spring. Fruit baring perennials such as apple (\textit{Malus sylvestris} L.), peach (\textit{Prunus persica} (L.) Batsch), and apricot (\textit{Prunus armeniaca} L.) sometimes break dormancy during unseasonably warm weather in late winter and flower, only to have this flush of fruiting buds destroyed by a return of freezing weather.

Phytohormones play a vital role in plant maturation, beginning with germination and in some cases ending with product consumption. Primordia development and tissue initiation necessary for successful reproduction is dependant on all phytohormones functioning properly throughout the plant’s life. Maturation is closely associated with senescence which is described by Arteca (1996, p. 116) as “terminal differentiation” and is an ongoing process in a plant. It is important in xylem differentiation, leaf development, and breakdown of specialized embryonic and female gametophyte cells. Senescence is important at the organ level with respect to decreases in available photosynthetic area, flowering, and fruiting (Noodén and Leopold, 1978). Factors such as temperature stress, drought, nutrient imbalances, shading, air pollution and pests’ pressure hasten senescence and have detrimental effects on reproductive growth and yield (Grover, 1993; Noodén and Leopold, 1978; Reddy et al., 1993).

In broad general terms senescence and eventual maturity, is delayed by the phytohormones: auxins, cytokinins, and gibberellins. Auxins are best known for their effects on cell division and elongation, but there are several reports of applications of natural and artificial auxins delaying senescence in a number of different tissues. On the other hand there are also reports of auxins interacting with other plant growth materials and inducing release of ethylene which facilitates senescence and maturity (Arteca, 1990). Cytokinins have been shown to inhibit leaf senescence in water-stressed plants, in part through stomatal aperture control and regulation of associated leaf water potential (Hale and Orcutt, 1987). Gibberellins generally delay senescence in leaves by retarding chlorophyll loss and reducing both RNA and protein degradation (Arteca, 1996, p. 170).

Ethylene, abscisic acid, and methyl jasmonate basically induce the opposite reactions in plants compared with the previously mentioned phytohormones and thus promote senescence (Abelès et al., 1992). Ethylene is gaseous in nature and the simplest of all plant hormones in chemical structure. It is produced by a three step breakdown of methionine (McKeon et al., 1995). With respect to maturation, ethylene is known to stimulate flower opening, ripening, and abscission of leaves and fruit. Abscisic acid or ABA, was first discovered as a compound...
that accelerated leaf abscission and bud dormancy in woody plants (Goodwin and Mercer, 1983, p. 606–614). However, it is now believed to have less of a role in leaf abscission and is more important in flower and fruit abscission as well as senescence and ripening processes of these organs. Methyl jasmonate is believed to promote senescence primarily by stimulating the production of ethylene (Arzec, 1996, p. 172).

**Maturity in Soybean**

Soybean is well known for being a short-day species and has different levels of sensitivity resulting in a broad range of adaptability for the crop across several latitudes. The crop is classified into Maturity Groups (MG) based on its response to light induced reproductive growth. Maturity groups range from MG 000, grown primarily in regions of southern Canada, to MG VIII which traditionally is produced in subtropical areas of the southern United States (Palmer and Kilen, 1987, McWilliams et al., 2004). Two other groups MG IX and MG X are adapted for production in the tropics. Adaptability of specific cultivars to a production area is usually a 200 to 300 km north-south band in latitude (McWilliams et al., 2004). Sensitivity of photoperiod induced flowering in soybean was found to be greater in later maturing cultivars than early ones (Criswell and Hume, 1972; Major et al. (1975a, 1975b). McWilliams et al. (2004), states soybeans adapted for the northern United States often require minimum daylengths >14 h to initiate flowering. They also concluded planting a specific cultivar at a higher latitude than it is adapted will result in extending vegetative growth and delaying both flowering and maturity. Conversely planting a cultivar at a lower latitude will shorten the period of vegetative growth, stimulate earlier flowering, and hasten maturity.

Besides maturity groups, soybean is also classified as either determinate or indeterminate based on its stem growth habit. Determinate plant types terminate stem growth with the onset of flowering (Bernard, 1972). Stem apices and axillary buds of main stem nodes are immediately transformed from vegetative to reproductive tissue in determinate plant types by exposure to daylengths shorter than critical. By contrast indeterminate plant types continue stem elongation and leaf growth several weeks after floral initiation. Maturity Groups 000 to MG IV soybean cultivars have generally been considered to have an indeterminate growth habit while the determinate characteristic has basically been confined to MG V’s and later (Heatherly and Elmore, 2004). Determinate plant types though are now present in MG III and MG IV cultivars and being developed for earlier maturity groups. Determinates are less prone to lodging but in some studies tended to yield less seed than indeterminates (Ablett et al., 1989; Robinson and Wilcox, 1998).

Planting date of soybean has been studied in several production areas across several maturity groups. Several studies in the southeastern United States show, that though soil moisture levels are more favorable for mid-April soybean planting, short photoperiods of that time result in shorter plants with lower seed yields (Johnson, 1987). Parker et al. (1981) reported two cultivars grown near Tifton, GA and representing MG V and MG VI, had decreases in days between planting to flowering as seeding was delayed from early April to early July. A similar decline occurred for both a MG VII and MG VIII cultivar in the same experiment with seedings beginning in early May to early July. Yields were lower for all cultivars for both early April and early July plantings compared with May plantings. Planting date research in Wisconsin demonstrated improved stands across any tillage system cannot compensate for yield declines resulting from shorter growing seasons due to later plantings (Oplinger and Philbrook, 1992). Nafziger (2003) reported for central Illinois, late MG III cultivars produced nearly 10% less seed when planted in early April than when planted in late May. De Bruin et al. (2004) cautioned Iowa soybean producers to refrain from planting a short-season cultivar in early April as an attempt to hasten soybean harvest. Such plantings are more susceptible to drought stress during seed fill and thus yield less.

Soybean production systems in the Mississippi Delta, have changed markedly within the past decade. From the time the species became an important cash crop for the mid-South during the 1950s, until the mid-1990s, most soybean cultivars grown were MG V, VI, and VII, usually planted in early to mid-May with an average yield of about 1400 kg ha−1 (Heatherly, 1998). These low yields were largely a result of drought and high temperatures during reproductive growth that began in late May. An early soybean production system is now practiced in much of the mid-South which involves planting MG III, IV, and V cultivars in late March to early May and irrigating. Plants reach physiological maturity by mid-summer with harvest beginning in early August. Recently Heatherly (2005), reported MG IV cultivars planted in April or May and irrigated produced greater seed yields with more irrigation efficiency than cultivars of later Maturity Groups. Under non-irrigated systems MG IV and MG V cultivars produced similar yields when planted in April and May. These changes in soybean production are largely responsible for state average yields for Mississippi during 2000 to 2005 being above 2200 kg ha−1 (National Agricultural Statistics Service, 2007).

**Maturity in Corn**

Temperature rather than daylength appears to play a greater role in determining developmental rates in corn (Duncan, 1975). With corn, temperature of the apical meristem has been shown to influence crop development rate, beginning with planting and continuing until anthesis (Brouwer et al., 1970; Milleder and McWilliam, 1968). Cultivars range in maturity from 50 d to over a year with their respective heights ranging from 0.75 m to more than 6 m and number of leaves ranging from 9 to 40 per plant (Martin et al., 1975, p. 326 and 501). Corn is grown in the western hemisphere uninterrupted from 58°N latitude to 35° to 40° S latitude and in areas below sea level to altitudes of nearly 4000 m.

Maturity differences in corn are equally important to crop management as they are with soybean. For many years corn maturity has been ranked by days from emergence to physiological maturity, with shorter season hybrids (85–105 d) being grown in northern ranges of the Cornbelt, mid-season hybrids (110–115 d) grown in latitudes of 39 to 42° N, and full-season hybrids (120 d) dominating the southern United States. In recent years the concept of growing degree days (GDDs) or preferably growing degree units (GDUs), has been adopted by both researchers and seed suppliers to better identify...
adaptability for particular hybrids. The concept of GDUs though is not really new. Wang (1960) discussed the history of formulating GDUs, going back to work by Réaumar in 1735. Shaw (1988) describes various methods used to determine GDUs in corn production. The GDU system most commonly used in corn production has a base temperature of 10°C with an optimum temperature of 30°C as determined by Cross and Zuber (1972). Bruns and Abbas (2005) use the phrase “GDU 10” to identify the 10°C base used for corn to distinguish it from other GDU systems with different base temperatures that have been developed for different crop species. Today most all extension services in the Cornbelt have bulletins available in print and on the internet that discuss GDUs for corn in great detail.

The assumption for many years was that corn hybrids which used as much of the available growing season as possible for an area would be highest yielding (Poehlman, 1959, p. 263; Larson, 2002). Full-season hybrids were recommended in the southern Cornbelt, mid-South, and the southeastern states because of the comparatively long number of days between the last killing frost in spring and the first one in fall. Short-season hybrids on the other hand were confined mainly to the northern Cornbelt because of the possibility of frost damage occurring before the grain matured. Recently, Bruns and Abbas (2005 and 2006) reported several short-season and midseason hybrids, when grown in the Mississippi Delta, produce grain yields comparable to full-season hybrids and without increased levels of mycotoxin contamination. Their findings (Bruns and Abbas, 2006) coincided with earlier research from the Cornbelt that seedings made before the optimum planting date for an area, suffered little or no yield loss, but those made after the determined optimum date regressed to produce less grain with increasing delays (Nafziger, 1994; Lauer et al., 1999). Other research on short-season corn hybrids grown in the mid-South found that such hybrids had similar yield potential and partial financial return, but higher plant populations were required with these hybrids which off-set gains made by reductions in irrigation costs (Popp et al., 2006). Early research on short-season hybrids in the western Cornbelt reported higher plant densities were required for such hybrids to achieve maximum yields compared to full-season types (Colville et al., 1964). This was determined to be due to short-season hybrids having less stature and fewer leaves than later maturing types. This resulted in them being unable to capture as much photosynthetically active radiation, reducing their yield per plant as compared with full-season hybrids.

Planting date has always been a factor in corn maturity and hybrid selection. Hybrids produced today appear to have early season tolerance to suboptimal growing conditions such as cold temperatures, wet soils, seedling diseases, and insects (Bruns and Abbas, 2006; Lauer, 2001). Improvements have also occurred in pesticides that better protect seedlings during germination (Lauer, 2005). These factors likely contributed to Kucharik’s (2006) conclusion that corn planting in North America is currently occurring 2 wk earlier than in 1980. North American farms which produce large hectarages of corn often plant hybrids of different maturities in different fields to spread out harvest time and environmental risks. Earlier maturing hybrids are often planted first followed by later maturing types. Ideally fields planted to later maturing hybrids will achieve harvest maturity just as harvesting of earlier hybrids is concluded.

Another management practice still employed by some growers is to fill half of their planter boxes with one hybrid and the other half with a hybrid that flowers 2 to 4 d later. This practice began in the 1950s with the belief that such blends would have a wider adaptation to differences in microenvironments across the field, spreading out pollination over a longer time, and have a yield advantage over planting a single hybrid (Rossman and Cook, 1966). Early research by Stringfield (1959) and Funk and Anderson (1964) though determined that blends did not produce greater grain yields than the component hybrids grown separately. Pendleton and Seif (1962) also demonstrated that alternate rows of dwarf and normal sized hybrids produced less grain than a solid stand of the normal sized hybrid. Despite these findings some growers continue the practice believing they are reducing their risks of poor pollination and resulting yield losses.

**MATURITY IN SMALL GRAINS**

Maturity rate in small grains, regardless of whether it is a winter annual requiring vernalization or a spring type requiring no vernalization, is heavily dependant on environmental conditions between anthesis and physiological maturity. Maturation in wheat is the result of plant senescence which is actually initiated just before anthesis with the loss of leaf area (Simmons, 1987). Adverse environmental conditions such as drought and excessive heat or insufficient nutrient levels, especially N, can hasten senescence and reduce leaf area duration which in turn reduces yield. Evans et al. (1975) found winter wheat grain yields may be positively correlated to leaf area duration during grain filling. A group of winter wheat cultivars named ‘Triumph’ types, developed by Joseph Danne, a private breeder in Oklahoma during the late 1940s and early 1950s, achieved harvest maturity earlier than most cultivars at the time of its release. Triumph became a dominate cultivar in the southern and central Great Plains, and was the leading cultivar grown in the United States in 1959 (Carver, 2007), largely because of its earliness and yield stability. Hard red winter cultivars that were developed later would frequently outyield the Triumph types, but yield stability and excellent grain quality of Triumph cultivars resulted in them remaining in production in the southern Great Plains into the early 1980s (L.I. Croy, personal communication, 1981).

Maturity in rice (Oryza sativa L.) is more cultivar dependent than other cereals, with several older cultivars grown primarily in the tropics being SDP. For many years rice cultivars have been classed as either *Indica* for the long-grain types or *Japonica* for the short-grain plants (Grist, 1975, p. 83–84). *Indica* cultivars tend to be taller, more subject to lodging, and are photosensitive or “date-fixed” with respect to maturity. It is believed these cultivars evolved in the tropics where they were planted when the monsoons arrived and matured at a fixed-date when the rains and flooding subsided (Philippines College of Agriculture and International Rice Research Institute, 1967). *Japonica* cultivars are believed to have developed in the subtropical to temperate climates with little or no photoperiod sensitivity and are referred to as “season-fixed”
having a fixed maturation period regardless of planting date (Grist, 1975, p. 83–84).

The maturation of paddy rice may vary from 90 to 260 d depending on plant genotype and the environment (Martin et al., 1975, p. 326 and 501). Longer-season cultivars tend to produce more tillers than earlier-season types. In the southern United States days from planting to maturity usually range from 120 to 140 d. For most of history growers needed to choose cultivars carefully with regards to photoperiod as growth duration, maturation date, and potential yield were influenced by their selection (Mikkelsen and DeDatta, 1980).

In the 1950s though, it was established that rice grain yields are not necessarily positively correlated with maturity rate. Both Larter (1953) and FAO and Ramiah (1954) stated that yields in early maturing cultivars are greatly dependant on other environmental factors and soil fertility. New high yielding cultivars grown today are fairly photoperiod insensitive (Oka, 1988).

Maturity in other small grains, namely barley, oat, rye, and triticale (*Triticosecale) is seldom of concern. With malting barley, grain development is monitored to determine physiological maturity at which time the crop is mowed and windrowed. After further drying, it is threshed with a combine equipped with a pick-up header attachment. This method of harvest reduces shattering losses that are often higher when the crop is allowed to field-dry and combined while still standing. With oats, both spring and winter cultivars, seeding is accomplished as early as possible to have kernel filling occur before the hot and dry part of the growing season. Little if anything has been written about maturity in rye and triticale.

**COTTON**

Defining maturity in cotton presents a unique challenge compared with other agronomic crops. A perennial by nature, cotton is farmed as such in several tropical regions of the world, but in the United States it is managed as a summer annual. Conventional cotton producers in the United States closely monitor their crop in early fall to determine when maximum economic yield has likely been achieved and apply defoliants that remove leaf tissue to facilitate mechanical harvest and reduce the amount of leaf material in the fiber. Bednarz and Nichols (2005) give a thorough review of the various phenological and morphological definitions of earliness in cotton. Munro (1971) defined earliness in cotton maturity as achieving an acceptable yield in the fewest days after planting. Bednarz and Nichols (2005) state that despite an absence of late season insect pressure due to insecticides and/or cultivars genetically modified for insect control with *Bacillus thuringiensis* (Bt), poorly drained soils and late season storms necessitates management for early maturity of cotton in some parts of the United States. They also state that for the lower southeastern United States, full-season cultivars may be better able to recover from exposure to brief periods of drought to produce more stable yields than early maturing cultivars.

In cotton the primary axis of the plant remains vegetative throughout its lifecycle and the plant’s reproductive growth is basically unaffected by photoperiod (Mauney, 1986). However, other environmental factors do influence the process. Mauney (1966) had earlier found the day/night temperatures as well as light intensity and quality can determine the placement of the first node to bear fruit. Differentiation of the first floral bud can begin as early as 10 to 14 d postemergence. Removal of the two or three fully expanded true leaves at this time will delay flowering. Bednarz and Nichols (2005) found that in the Coastal Plain of Georgia, nine commercial cotton cultivars began flowering 57 to 64 d after planting and continued for 25 to 30 d thereafter. Normally effective flowering, flowering that contributes to economic yield, begins 60 d after planting and continues for about 20 d.

The phenophase where effective flowering terminates is referred to as “cutout.” Bourland et al. (1992) defined this to occur in the mid-South with the appearance of the first sympodial position white flower five main stem nodes from the main stem apex. However, Bednarz and Nichols (2005) state that in the southeastern United States where late season weather and insect pressure are not as great a problem, effective flowering may continue to the first sympodial position white flower three main stem nodes from the main stem apex.

Flowering in cotton occurs in intervals that were first reported by McClelland (1916) as being 3 d vertical and 6 d horizontal. Godoy and Palomo (1999) report that horizontal flowering intervals are a genetic trait that can be manipulated while Bednarz and Nichols (2005) states that this trait has likely been manipulated in selecting for earlier maturing cultivars. Their research (Bednarz and Nichols, 2005) recently reported that with modern cultivars in the Coastal Plain of Georgia, these intervals were 2.5 and 3.8 d vertical and horizontal, respectively. But, they cautioned that flowering intervals in cotton are temperature, nodal, and cultivar dependent.

Boll maturation is defined as the number of days between white flower appearance to cracked boll. This period has been determined to be strongly influenced by temperature (Morris, 1964; Gipson and Ray, 1970; Hesketh et al., 1972, 1975). The GDU 15’s (growing degree units base 15°C) required for boll maturation was determined by Oosterhuis et al. (1996) to be 470°C d. Bednarz and Nichols (2005) though observed GDU 15’s varied from year to year and were consistently greater than those reported by Oosterhuis et al. (1996). They concluded that boll maturation cannot be defined solely on the basis of GDU 15’s or calendar days.

**SUMMARY**

Every plant species, agronomic, horticultural, forest, or weed has its own unique lifecycle, designed through evolution for the purpose of reproduction. Most of our cultivated crop species have lost the ability to self-propagate due to mass selection over the millennia of civilization to maximize production of that plant organ beneficial to humankind. Corn is a prime example of a species that has become totally dependent on humans to survive and is unable to propagate itself. Many wild plant species are dependent on animals to assist in their propagation, both in pollination and seed dissemination. The above text is brief summaries of maturation for some of the more important agronomic feed, food, and fiber crops grown in the Americas. It is not the definitive answer to questions about maturation in these species, as such a project could easily occupy a text book, but rather a starting point for comprehensive study of crop maturity.


