

# Revised Planting Window For Full Season Cotton Varieties

*P. Brown, J. Silvertooth, L. Moore and T. Watson*

## *Abstract*

*A heat-unit-based planting window was introduced in 1991 as a means of reducing early season problems with pink bollworm (PBW). Growers were encouraged to plant full season varieties when the annual heat unit (HU) accumulation ranged between 600 and 900 -- a window designed to ensure 75% suicidal emergence of PBW yet maintain acceptable yield levels. New research findings and a reexamination of past PBW emergence studies now support making an adjustment to the planting window. For 1992, the recommended planting window is 450 - 700 HUs after January 1.*

## Introduction

Heat-unit-based planting windows were introduced during the 1991 cotton season to help growers avoid early season pink bollworm (PBW) infestations. The driving force behind development of the planting window was the severe PBW infestation that devastated many cotton fields in 1990.

The major target of the planting window program was full season cotton varieties. The long growing season required of full season varieties often results in early planting dates and increased crop susceptibility to early season PBW pressure. Adjustments (delays) in planting dates have been suggested by entomologists as a means of reducing early season PBW pressure; however, few growers have accepted this idea, believing delayed plantings significantly reduce yields. In 1991, the authors developed a planting window for full season varieties based on annual heat unit (HU) accumulations. Growers were encouraged to plant full season varieties when the annual HU accumulation ranged from 600 - 900. Research results at the time suggested this window offered the best compromise between planting early for optimal yield performance and planting late for PBW control. New research results now indicate some alteration is necessary in this planting window. This paper reexamines the basis for the 1991 planting window, then presents new evidence which supports adjusting the window and finishes by describing the procedure used to develop the adjusted planting window for 1992.

## The 1991 Planting Window

The 1991 planting window was established to 1) provide a planting period that would allow full season cotton varieties to attain optimal yields and 2) ensure that 75% of the PBW moths emerging from overwintering (diapause) would do so before cotton reached the susceptible square stage (75% suicidal emergence). The critical step in developing the window involved normalizing three components of the early season cotton system -- early season cotton development, spring emergence of PBW and planting date/yield relationships of full season varieties -- to some common time scale. Thermal time, or HUs were selected as the time scale based on past work by Dennis and Briggs (1968), Huber (1982) and Silvertooth et al. (1991a, 1991b). Dennis and Briggs (1968) and later Silvertooth et al. (1991b and 1992a) revealed that early season cotton development could be predicted using HUs (upper and lower temperature thresholds of 86F and 55F, respectively; Figure 1). Huber (1982), working with the same HU system, found PBW spring emergence could be predicted by tracking the annual accumulation of HUs (Figure 2). Finally, Silvertooth et al. (1991a) concluded from a

series of planting date trials that full season cotton varieties perform best if planted when the annual HU accumulation is between 300 and 900 (Figure 3). The planting date description shown in Figure 3 represents a broad interpretation of acceptable planting conditions for full season varieties, with regard to maintaining acceptable yield potentials.

Actual selection of the planting window proceeded in the following manner. First, the annual HU requirement necessary to achieve 75% PBW spring emergence was set equal to 1500 based on the work of Huber (1982). To accomplish 75% suicidal emergence the next step was to set an initial planting date that would ensure no cotton had susceptible squares at 1500 HU after January 1. This was achieved by subtracting 900 HUs -- the HU requirement after planting for cotton to reach susceptible square -- from 1500. The resulting HU value of 600 fell in the middle of the optimal HU range for planting full season varieties and therefore was deemed an acceptable HU value for opening the planting window (Figure 4). The ending or closing HU value for the window was set equal to 900 -- the endpoint of the optimal HU range for planting full season varieties (Figure 4).

### **Adjustments In The Planting Window For 1992**

Additional research findings and a reexamination of past PBW emergence studies has provided the impetus for altering the planting window in 1992. Silvertooth et al. (1992b) now recommend shortening the planting period for full season varieties to 300 - 700 HUs after January 1 (Figure 5). Their work indicates full season varieties have a lower yield potential and produce more vegetative plants when planted after the annual HU accumulation exceeds 700-750.

On the issue of PBW spring emergence, Brown and Watson (unpublished) initiated 1) a series of new PBW emergence studies and 2) a program to reexamine past PBW emergence work in 1991. Their work to date indicates spring emergence of PBW is affected by both HUs and soil moisture. Figures 6 & 7 show some of their findings. Figure 6 shows two examples where PBW spring emergence follows the standard HU model described by Huber. In both cases, rainfall and soil moisture were low during the bulk of the winter and early spring. In contrast, Figure 7 shows two examples of PBW emergence under conditions of high soil moisture (caused by rainfall or early season irrigation). In both circumstances, spring emergence was much earlier than predicted by HUs alone (Huber model). While this research work is continuing, the authors believe high levels of soil moisture can contribute to an earlier PBW emergence (Figure 8), and in years with significant winter and spring rainfall, or where pre-irrigation is used, an earlier spring emergence is likely. The research to date suggests this "earliness", in terms of HUs, ranges from 150-300.

Given the work on yield and planting date by Silvertooth et al. (1992b) and the work by Brown and Watson on PBW emergence, the authors believe adjustments in the planting window are warranted for 1992. The rationale and procedures used to make the adjustments follow.

The critical step in establishing a revised planting window involved making an adjustment in the annual HU accumulation required to attain 75% PBW spring emergence. A conservative reduction of 150 HUs to 1350 HUs after January 1 was selected. Justification for this change comes from the aforementioned discussion on the moisture/PBW emergence relationship, the level of winter rainfall (November 1991 through February 1992), and the fact that much of Arizona's cotton is pre-irrigated. Next, 900 -- the number of HUs required for cotton to attain susceptible squares -- was subtracted from the 1350 to establish the earliest planting date that would achieve 75% suicidal emergence. The result, 450 HUs after January 1, was set as the starting point for the planting window. Finally, the ending point for the planting window was set equal to 700 HUs after January 1 -- the end of the HU range deemed acceptable for planting full season varieties (Figure 9).

## Precautions With The 1992 Planting Window

The recommended HU planting window for full season cotton varieties in 1992 is 450 - 700 HU after January 1. When compared with the 1991 planting window of 600 - 900 HU after January 1, the 1992 window will result in earlier planting dates. Table 1 lists the calendar dates when both the 1991 and 1992 windows would open and close under normal conditions for several Arizona cotton production areas. In general, the 450-700 HU window opens about 14 days earlier than the 600-900 HU window.

Given the much earlier planting dates, a precaution on the importance of soil temperature to germination is warranted. Growers planting at 450 HU may find soils too cold for optimal germination in some circumstances and are advised to check soil temperatures before planting. Planting should proceed once the annual HU accumulation reaches 450 only if soil temperatures are optimal and the 5-day forecast is favorable (warm). Early morning soil temperatures at seeding depth should exceed 60F (ideally 65F) for good germination.

Another point worthy of discussion relates to pinhead square treatments and the planting window. One of the primary objectives of the planting window is to take advantage of suicidal emergence of PBW adults from overwintered larvae. A good goal is to reach about 95 percent PBW emergence before unprotected susceptible squares are present for egg laying. Pinhead square insecticide treatments can be used to extend the protected period toward the 95 percent emergence goal. It is possible, however, that more than 3 weekly treatments will be required to reach the 95 percent level when planting begins at 450 HU, particularly if emergence is delayed due to dry soils or other unknown reasons. The possibility of secondary pest problems as a result of beneficial insect suppression increases as the number of pinhead square treatments increases. Therefore it becomes questionable whether or not more than about 3 treatments can be justified. It is important to note that pinhead square treatments are most effective when growers within a community collectively decide upon a HU-soil temperature level at which planting will begin. Uniformity of planting within the community is more important than the exact time for beginning the planting window.

Finally, some discussion of medium and short season varieties and how they fit into the planting window concept is appropriate. The planting window, while expressly targeted at full season cotton production, should represent an acceptable planting time for all cotton maturity groups. Medium and short maturity type cottons will perform well when planted in the window, provided soil temperatures at planting and general growing season weather conditions are acceptable. One benefit of planting the medium and short maturity varieties in the window is the possibility of an early crop termination date. Terminal irrigations as early as late July are a distinct possibility for elevations below 2,000 ft. when these varieties are planted in the window. Early termination will greatly lessen problems with PBW diapause and whiteflies.

## References

- Dennis, R.E. and R.E. Briggs. 1968. Growth and development of the cotton plant in Arizona. Ext. Rpt. 8168. Univ. of Arizona, Tucson, AZ. 8 p.
- Huber, R.T. 1982. Heat units and population prediction. In Proc. 1982 Beltwide Cotton Production Mechanization Conf. 6-7 Jan. 1982. Las Vegas, NV. p. 54-55.
- Silvertooth, J.C., T.F. Watson, L.I. Terry and J.E. Malcuit. 1991a. Evaluation of date of planting and irrigation termination on the yield of Upland and Pima cotton. In J. Silvertooth and M. Bantlin (ed) Cotton: A College of Agriculture Report. P-81. College of Agriculture. Univ. of Arizona, Tucson, AZ. p. 1-14.
- Silvertooth, J., P. Brown and J. Malcuit. 1991b. Basic cotton development patterns. In J. Silvertooth and M. Bantlin (ed) Cotton: A College of Agriculture Report. Series P-81. College of Agriculture. Univ. of Arizona, Tucson, AZ. p. 152-159.

Silvertooth J.C., P.W. Brown, and J.E. Malcuit. 1992a. Cotton crop growth and developments patterns. In J. Silvertooth (ed) Cotton: A College of Agriculture Report. (This issue). College of Agriculture. Univ. of Arizona, Tucson, AZ.

Silvertooth, J.C., T.F. Watson, J.E. Malcuit and P.W. Brown. 1992b. Evaluation of date of planting and irrigation termination effects on yield of Upland and Pima cotton. In J. Silvertooth (ed) Cotton: A College of Agriculture Report. (This issue). College of Agriculture. Univ. of Arizona, Tucson, AZ.

Table 1. Normal opening and closing dates for the 1992 and 1991 planting windows for selected cotton production areas.

<u>Location</u>	<b>1992 Planting Window</b>		<b>1991 Planting Window</b>	
	<u>Open (450 HU)</u>	<u>Close (700 HU)</u>	<u>Open(600 HU)</u>	<u>Close (900 HU)</u>
Aguila	Apr. 15	May 6	Apr. 28	May 20
Buckeye	Mar. 22	Apr. 13	Apr. 5	Apr. 27
Casa Grande	Mar. 24	Apr. 15	Apr. 8	Apr. 30
Chandler Hts.	Mar. 27	Apr. 17	Apr. 10	May 1
Coolidge	Mar. 24	Apr. 16	Apr. 8	May 1
Dateland	Mar. 18	Apr. 9	Apr. 1	Apr. 22
Eloy	Mar. 23	Apr. 14	Apr. 7	Apr. 28
Florence	Mar. 23	Apr. 15	Apr. 7	Apr. 30
Gila Bend	Mar. 18	Apr. 8	Mar. 31	Apr. 22
Laveen	Mar. 23	Apr. 14	Apr. 6	Apr. 28
Litchfield Pk.	Mar. 22	Apr. 13	Apr. 5	Apr. 27
Maricopa	Mar. 29	Apr. 19	Apr. 12	May 3
Parker	Mar. 18	Apr. 7	Mar. 31	Apr. 20
Sacaton	Mar. 27	Apr. 19	Apr. 11	May 3
Safford	Apr. 20	May 12	May 4	May 25
Salome	Apr. 1	Apr. 23	Apr. 15	May 8
Tucson	Apr. 3	Apr. 25	Apr. 17	May 9
Wellton	Mar. 21	Apr. 12	Apr. 4	Apr. 27
Yuma Valley	Mar. 16	Apr. 7	Mar. 30	Apr. 22

## COTTON DEVELOPMENT TIMELINE

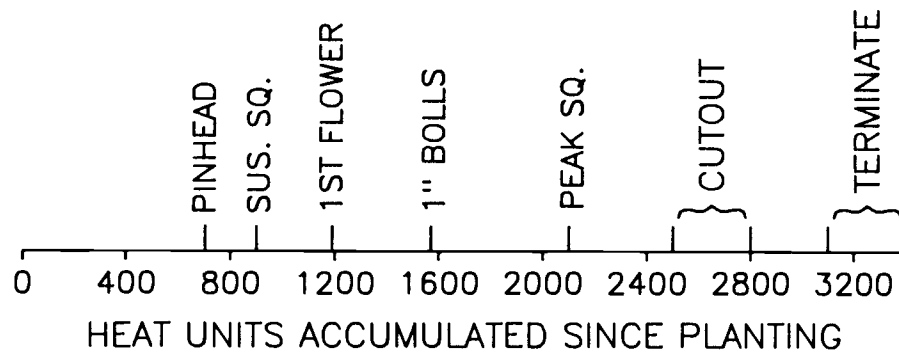


Figure 1. Cotton development timeline as a function of heat unit (86F/55F) accumulation.

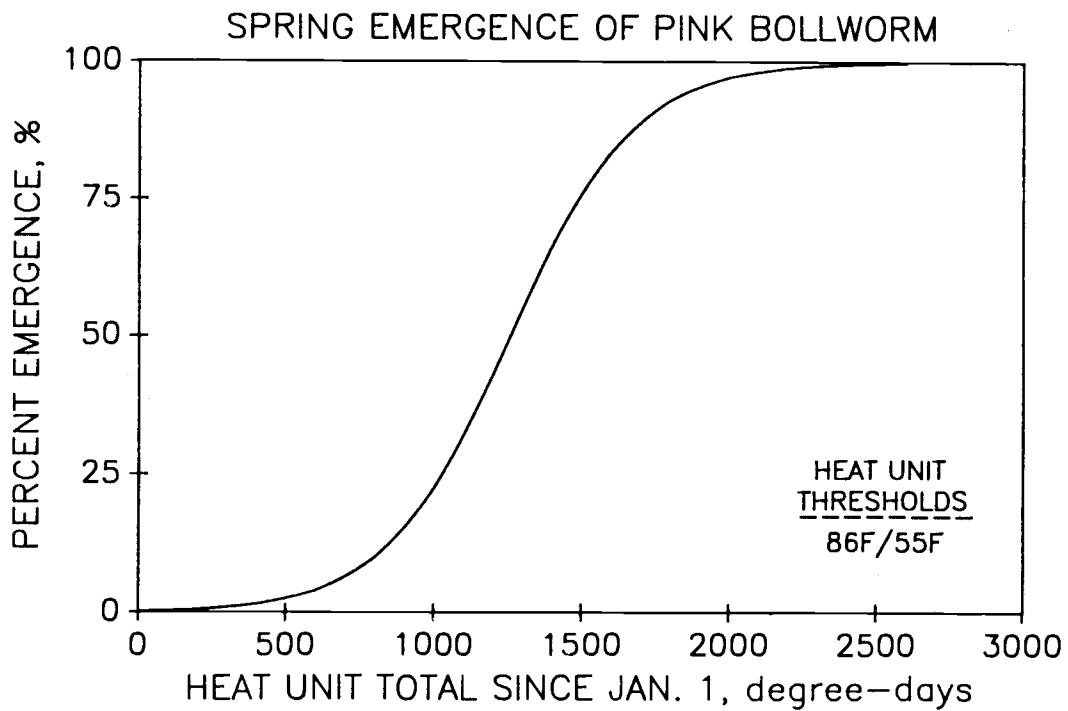


Figure 2. Pink bollworm emergence as a function of heat unit accumulation after January 1 (after Huber, 1982).

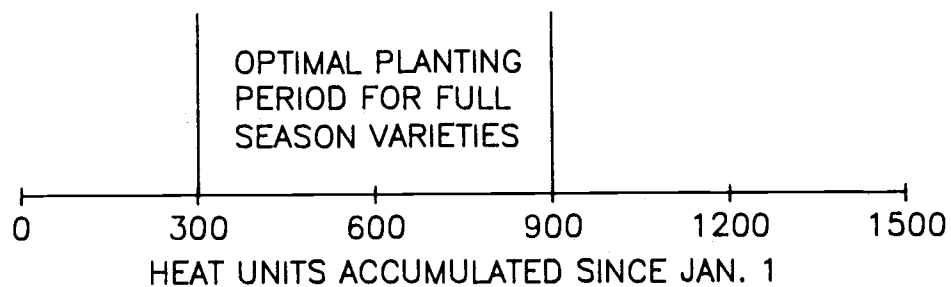


Figure 3. Recommended planting period in terms of annual heat unit (86F/55F) accumulation for full season cotton varieties in 1991.

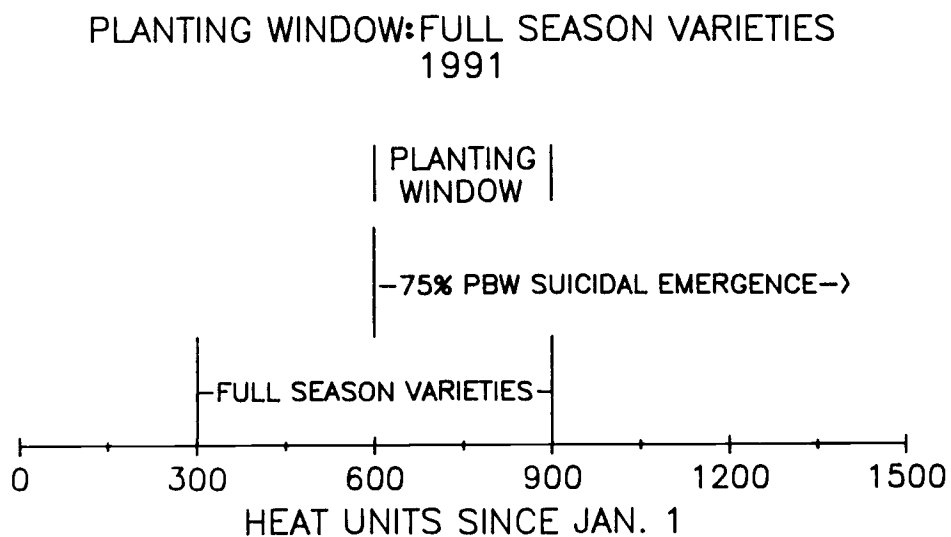


Figure 4. Rationale for the 1991 planting window for full season cotton.

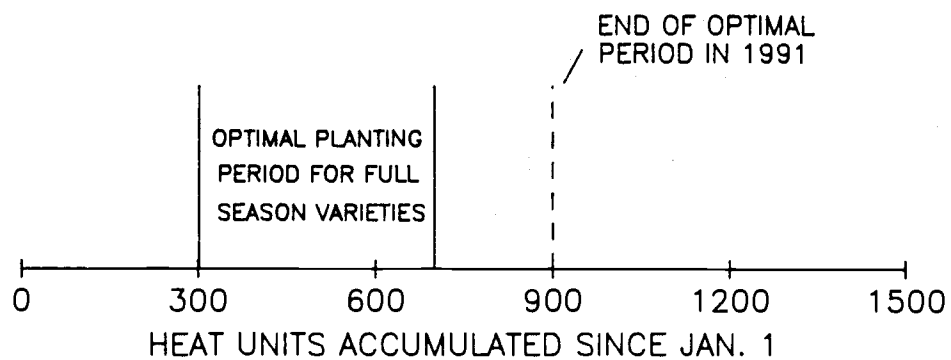


Figure 5. Recommended planting period in terms of annual heat unit (86F/55F) accumulation for full season cotton varieties in 1992. The end point of the optimal planting period used in 1991 is indicated with a dashed line.

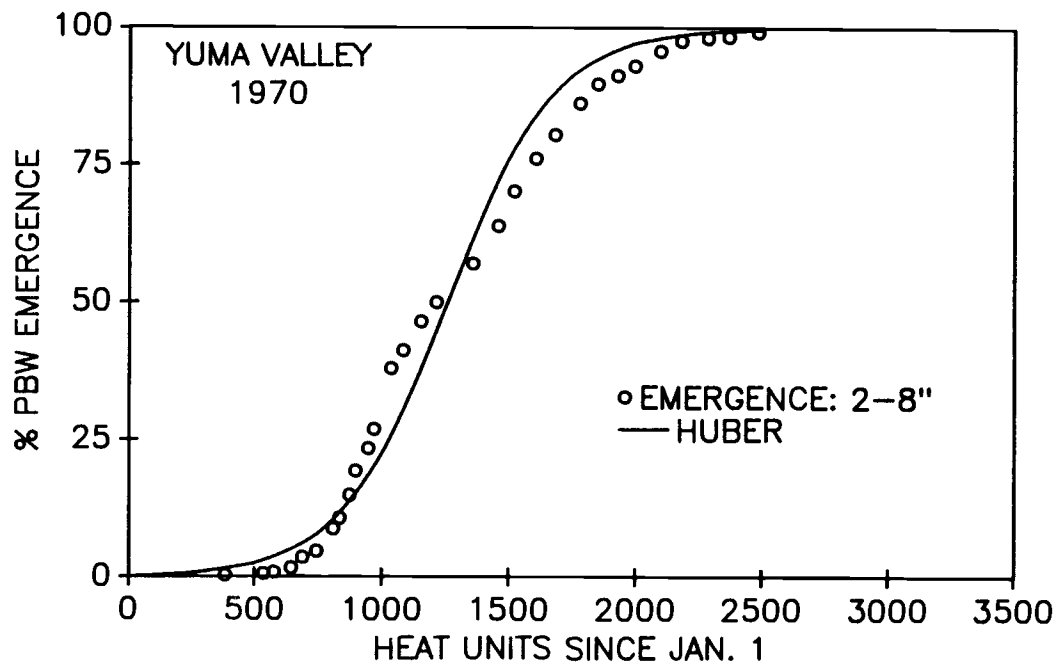
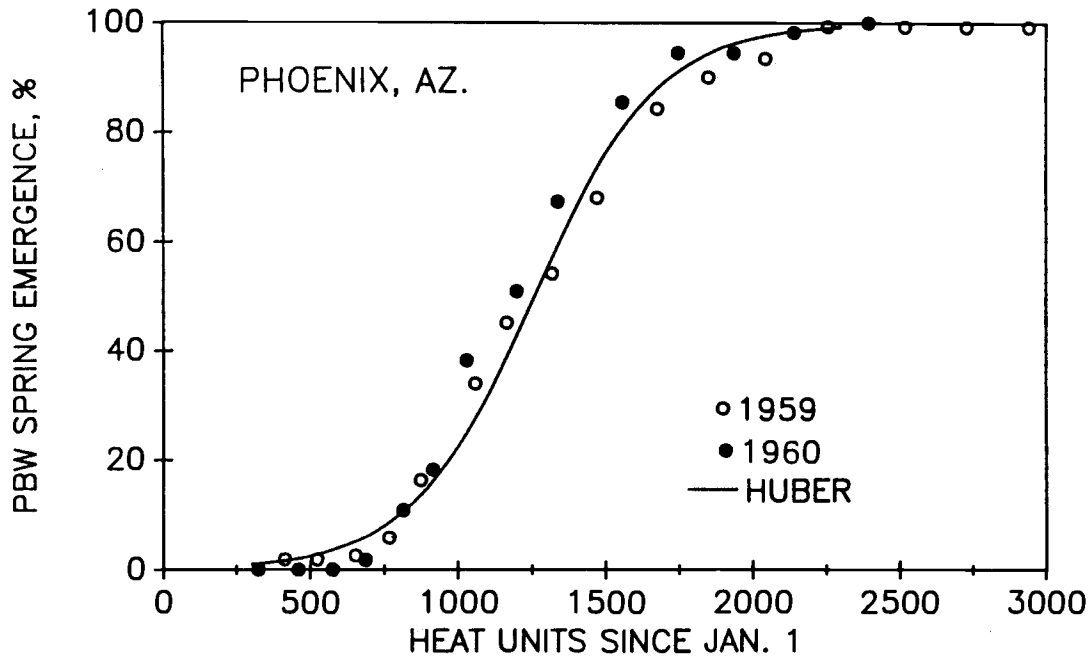


Figure 6. Past pink bollworm emergence studies conducted in Phoenix and Yuma Valley when dry soil conditions prevailed. The smooth curve is the HU model of Huber (1982).

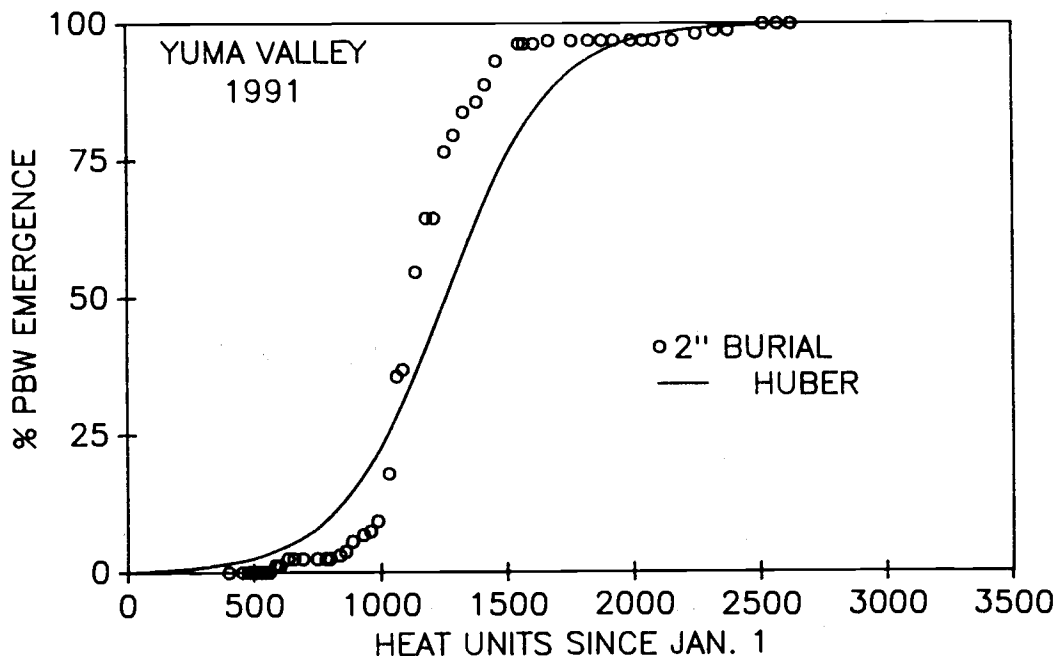
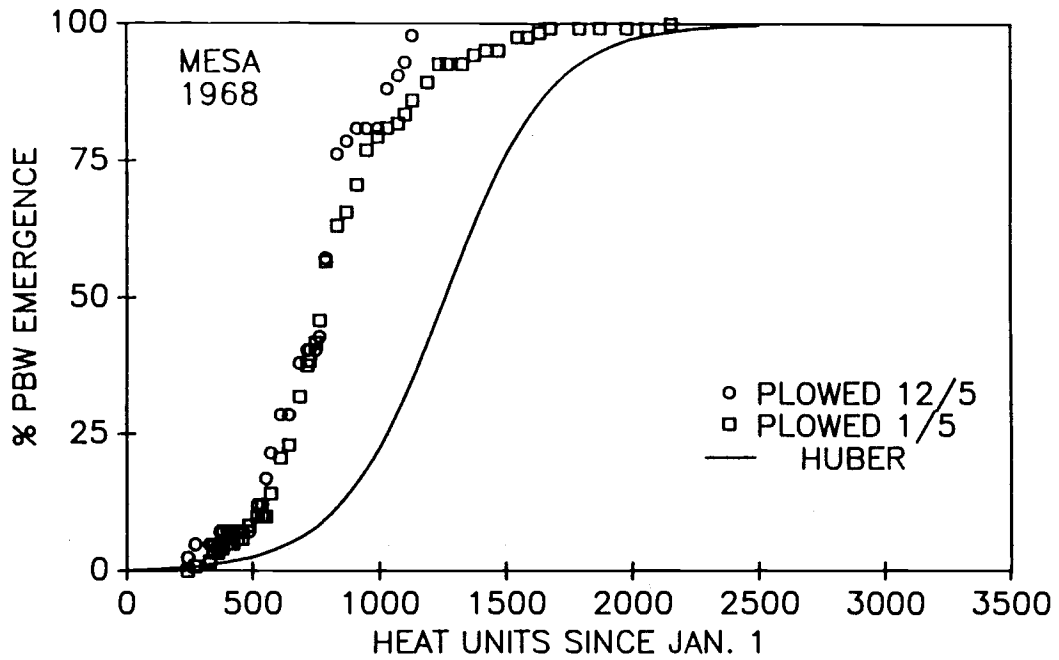


Figure 7. Past pink bollworm emergence studies conducted in Mesa and Yuma Valley when soil conditions were moist. The smooth curve is the HU model of Huber (1982).

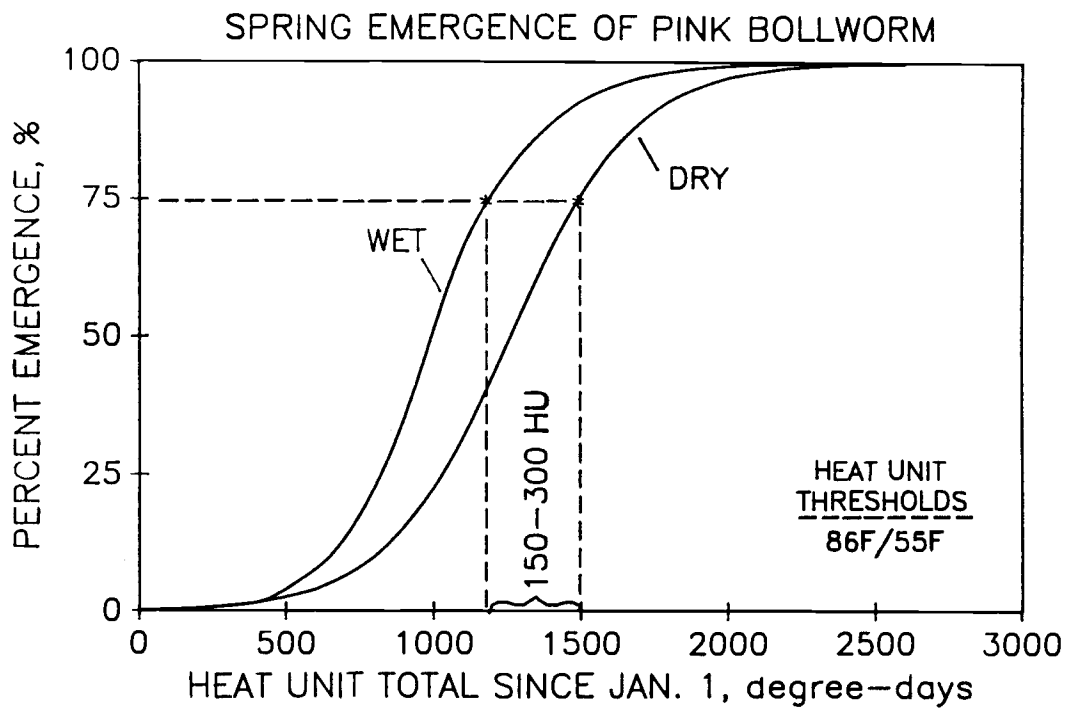


Figure 8. Representation of PBW spring emergence under dry and wet soil conditions. The dry curve is the HU model of Huber (1982).

PLANTING WINDOW: FULL SEASON VARIETIES  
1992

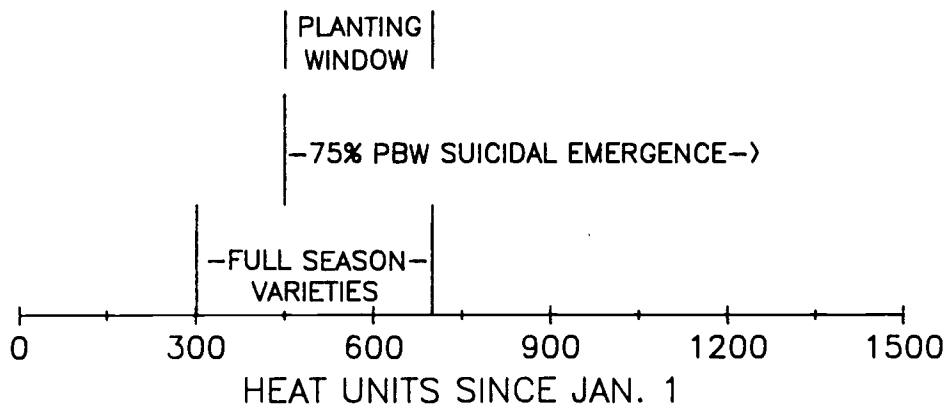


Figure 9. Rationale for the 1992 planting window for full season cotton.