Agronomic Evaluations of Transgenic Cotton Varieties

J.C. Silvertooth and E.R. Norton
University of Arizona

Abstract

Several field experiments were conducted in many of the cotton growing areas of Arizona in 1997 for the purpose of evaluating agronomic characteristics of many new transgenic Upland cotton varietie. In many cases, the new transgenic lines were compared directly with their recurrent (non-transgenic) parents. Evaluations were carried out by collecting plant mapping data from each variety on a regular 14 day interval throughout the season and relating the resultant information to established baselines for Upland cotton in Arizona. Lint yield measurements were also taken on each variety at all locations. Results indicate that all transgenic lines tested are very similar to their recurrent parents in terms of growth, development, and yield. Some subtle differences were noted but they were very slight and should impact management of the varieties significantly in comparison to their recurrent parents.

Introduction

The cotton plant is the centerpiece to a cotton production system. Accordingly, the variety being grown is extremely important. Transgenic varieties can possess tremendous potential by providing unique tools to the farmer, being delivered directly in the plant system. However, it is important that the variety carrying the transgenic property is a strong variety for the situation in which it is being used. It is also important to note that although statements may be made relative to a new transgenic variety being "the same as" it's non-transgenic parent variety; the new transgenic variety is actually a separate and unique variety. Under these circumstances it becomes even more critical to have access to objective, well documented information regarding the agronomic nature (growth, development and yielding potentials in response to soil and environmental factors) of the variety in question. This point was illustrated quite dramatically in 1997 with concerns and reports of problems associated with several Roundup Ready (RR) cotton varieties in some of the mid-south states.

As an example, the most critical difference associated with a Bt variety is that it contains some genetic information that was extracted from a naturally-occurring soil bacteria called *Bacillus Thuringiensis*, or Bt, which has insecticidal properties. Essentially, this genetic information was spliced into the cells of cotton plants and crossed back into favorable varieties through conventional breeding techniques. Accordingly, it is important to note that the Bt varieties that we are dealing with in the field are very similar to their non-Bt counterparts, but they are unique varieties in themselves. With or without internally controlled insecticidal properties, the variety of cotton plants grown in a field has a tremendous impact on the yield potential of the crop. Therefore, monitoring the agronomic characteristics of a Bt variety, as with any variety, is an important part of the variety evaluation. This is true not only for Bt cotton, but also for any new transgenic variety that is developed (i.e. Roundup Ready or Buctril resistant varieties).

To be competitive and to maintain economic sustainability in either a short- or long-term sense, it is important that cotton growers in Arizona have access to the best and latest in technology. To use this technology effectively, it is equally important to have a complete understanding of what the technology offers and what it can and cannot do. To utilize transgenic varieties effectively and to provide appropriate management, it is very important to understand the agronomic characteristics of them.

The purpose of this study was to compare the crop growth, crop development, and yield of several new transgenic varieties against both their recurrent parents and also against established crop growth and development baselines for Arizona cotton.

Methods

A group of field experiments were conducted at several locations across Arizona in 1997 containing numerous transgenic cotton lines that are being evaluated for introduction into the commercial market in 1998 (Table 1). Lines include varieties with Bt genes and Roundup Ready (RR) genes. Several of these lines are being prepared for possible release in 1998 (i.e. DP 20b, 50b, 90b, and 32b).

For each primary site (seven) in this project, a complete battery of crop growth and development parameters were conducted on all pertinent varieties throughout the season on approximately 14 day intervals (Table 2). The following measurements were made in each plot on all dates of sampling: plant height, number of mainstem nodes, node of the first fruiting branch, aborted sites at positions one and two, the number of nodes above the top white flower (NAWF), and petiole nitrate-N concentrations. From these measurements we calculate the height to node ratio (HNR) and percent fruit retention (% FR), which is plotted along with petiole NO_3^--N and NAWF values for each treatment relative to established baselines for these parameters. Harvest and lint yield estimates were conducted at all locations (13 locations total). In each case, seedcotton yields, turnout, lint yields, and HVI measurements were conducted for each set of transgenic/non-transgenic.

Results

Results are shown in figures 1 – 34.

Basic features evident from this data include the following points:

- Most transgenic lines are very similar to their recurrent parents.
- The problems associated with RR varieties reported from several locations in the mid-south in 1997 were not apparent in any of these studies.
  - Misshapen bolls and lower rates of fruit retention were not detected for RR varieties.
- Slight differences were detected between some varieties in terms of vigor and in-season fruit retention.
- Most of the new varieties are sensitive to stress, which is commonly expressed by low vigor and reduced fruit retention.
- Differences in yield were not attributed to agronomic properties.
- DP 33b does <u>not</u> have greater growth/vegetative tendencies than 5415 (vigor / HNR).
- DP 33b was consistently a high yielding variety across locations. DP 32b also yielded very well and demonstrated good consistency.
- Agronomic evaluation of transgenic lines without a direct comparison to the recurrent parent is possible in Arizona due to the availability of regional baselines for vigor (HNR, FR, NAWF, etc.).
- Transgenic lines of this type are commonly not placed in advanced strain studies. Therefore, studies of this type are needed for the evaluation and comparison of transgenic lines.

Table 1. Locations and parameters measured for transgenic variety comparison trials, Arizona, 1997.

Location	Varietes Observed	Crop Growth and Development Measuremnts	Yield
Mohave Valley	DP 5414RR DP 5690RR DP 90RR DP 32B DP 33B DP 5415		X
Parker Valley	DP 33B DP 20B DP 50B DP 90B DP 35B DP 32B		X
Buckeye	DP 90 DP 90RR DP 50 DP 51 DP 50B DP 20 DP 20B DP 5415RR DP 33B DP 32B DP 5690RR DP 35B	X	X
Paloma Ranch	DP 20 DP 20B DP 5415RR DP 33B DP 32B DP 5690RR DP 35B DP 90RR DP 90B	X	X
Tolleson	DP 33B DP 35B DP 90B DP 50B DP 20B DP 32B DP 5415		X
Higley	DP 35B DP 33B DP 90B DP 50B DP 20B DP 32B		X
Maricopa	DP 33B DP 5415	X	X

Table 1 (cont.). Locations and parameters measured for transgenic variety comparison trials, Arizona, 1997.

Location	Varietes Observed	Crop Growth and Development Measuremnts	Yield
Maricopa	DP 5690RR DP 5415RR DP 90RR DP 35B DP 33B DP 90B DP 32B DP 20B DP 50B DP 5415 DP 5690	X	X
Casa Grande	DP 90RR DP 5415RR DP 5690RR	X	X
Casa Grande	DP 50 DP 5690 DP 33B DP 35B DP 90RR DP 32B DP 5690RR DP 50B DP 51 DP 20 DP 20B DP 90B DP 5415RR		X
Coolidge	DP 50B DP 20B DP 32B DP 90B		X
Marana	DP 33B DP 5415	X	X
Marana	DP 32B DP 20B DP 33B DP 50B DP 90B BXN 47 STV 474 DP 50 DP 20 DP 90RR DP 5415 DP 5415RR DP 90	X	X

Table 2. Measurements taken to assess crop growth and development.

Plant Height
Number of Mainstem Nodes
First Fruiting Branch
Number of Missing or Aborted Fruiting Sites
Number of Nodes Above Top White Flower
Number of Blooms / 50 ft of Row
Percent Canopy Closure

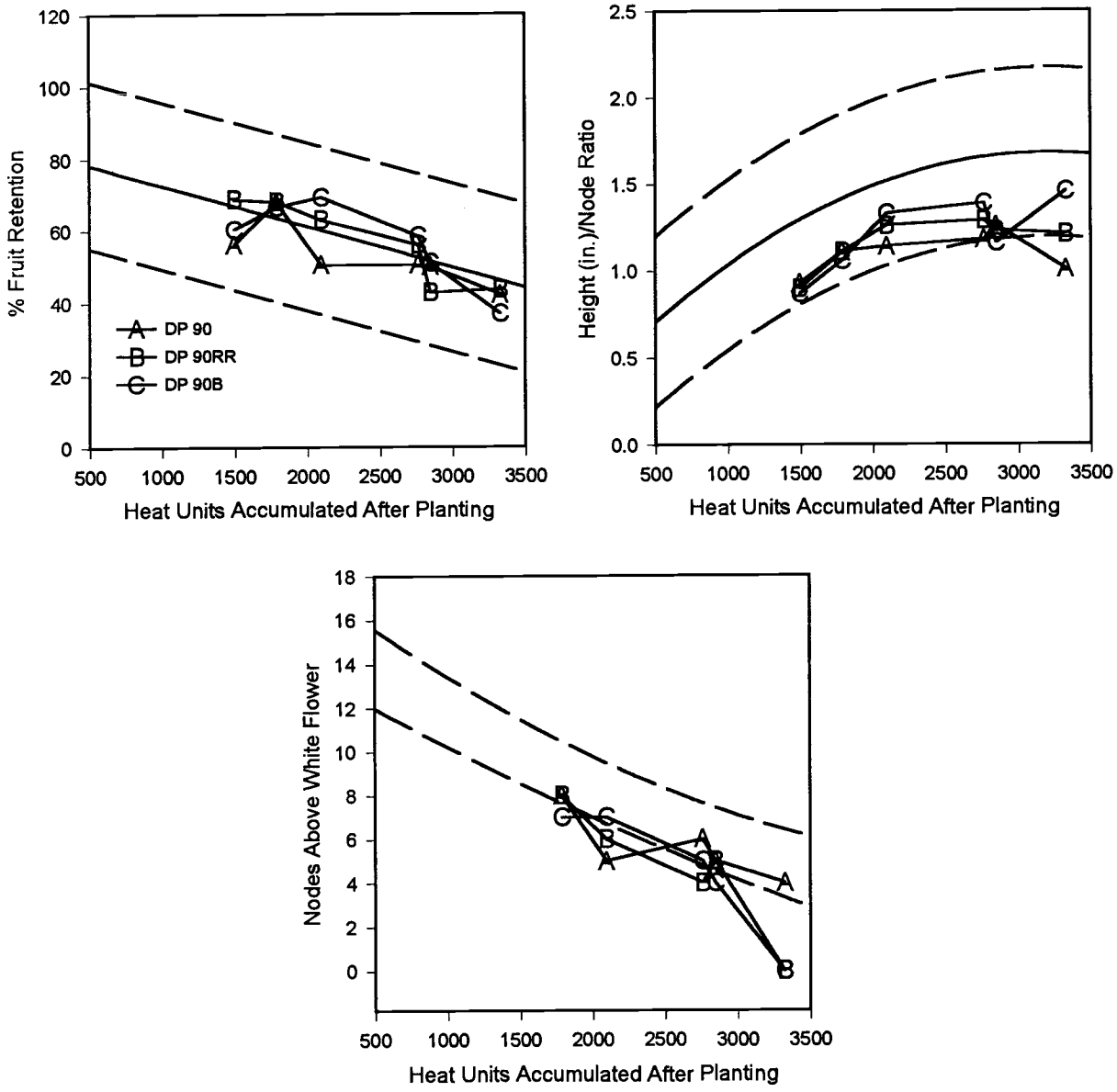

Figure 1. Plant growth and development comparisons for Bt vs. non-Bt varieties, Buckeye, AZ, 1997.

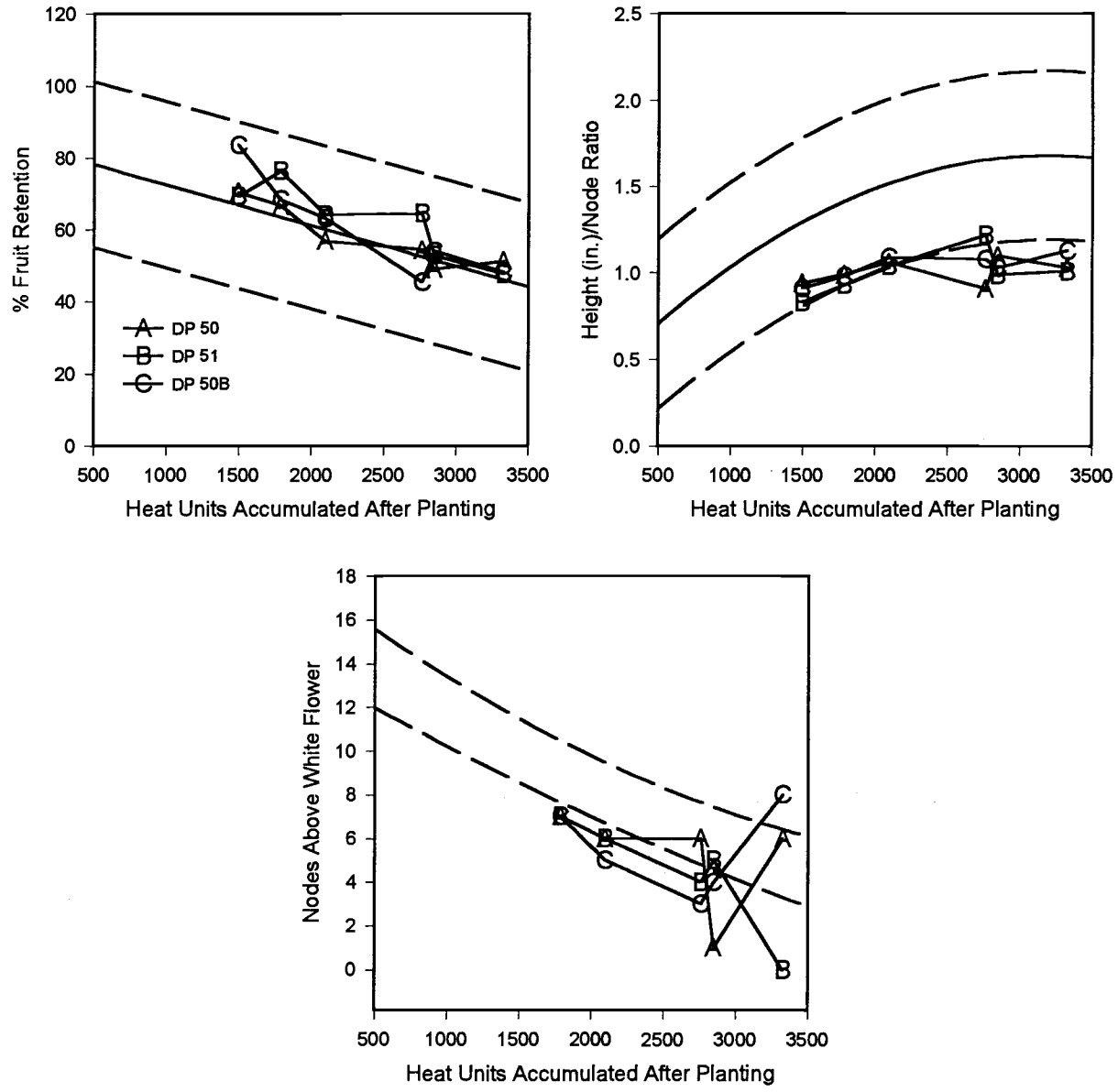

Figure 2. Plant growth and development comparisons for Bt vs. non-Bt varieties, Buckeye, AZ, 1997.

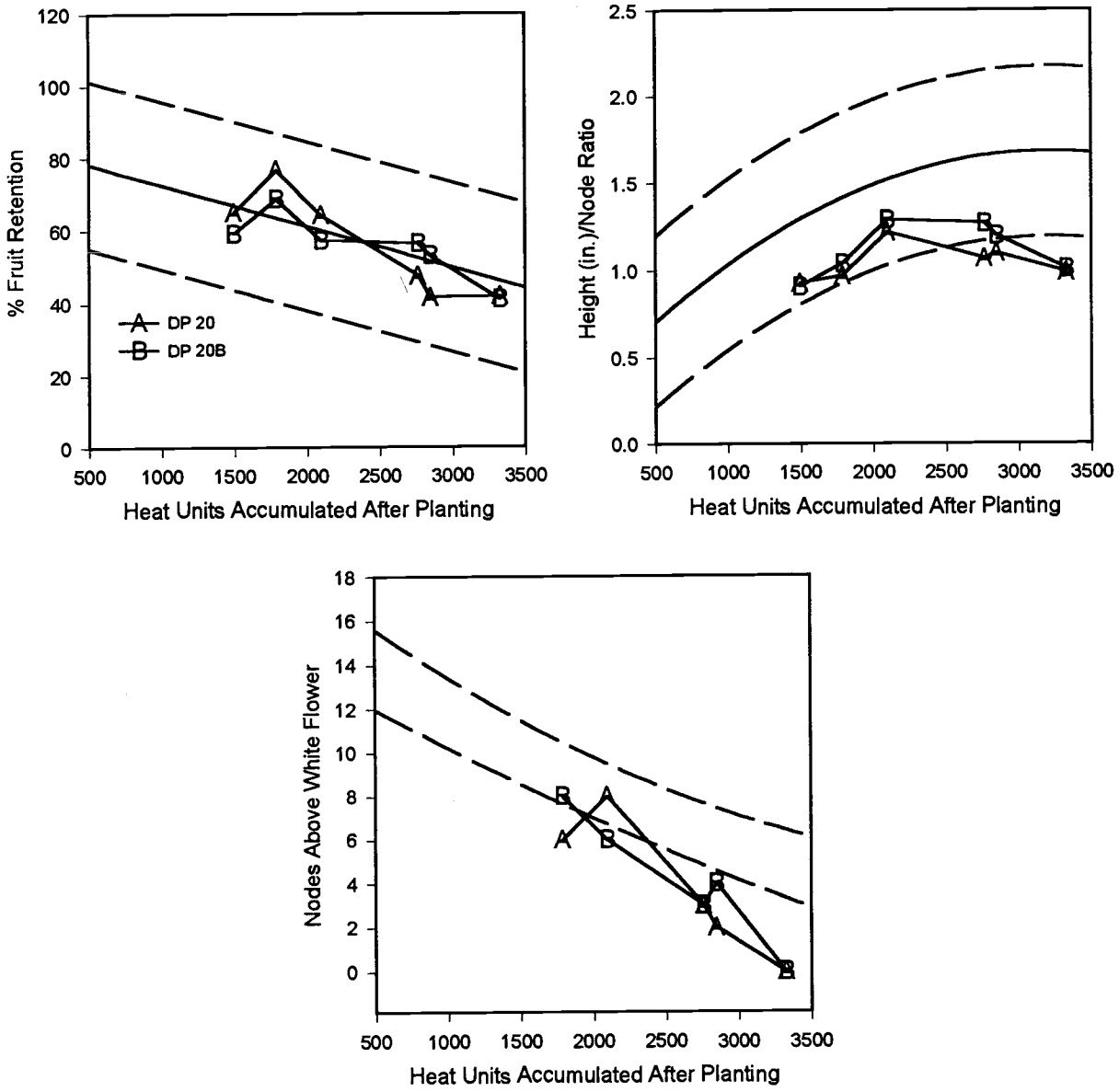

Figure 3. Plant growth and development comparisons for Bt vs. non-Bt varieties, Buckeye, AZ, 1997.

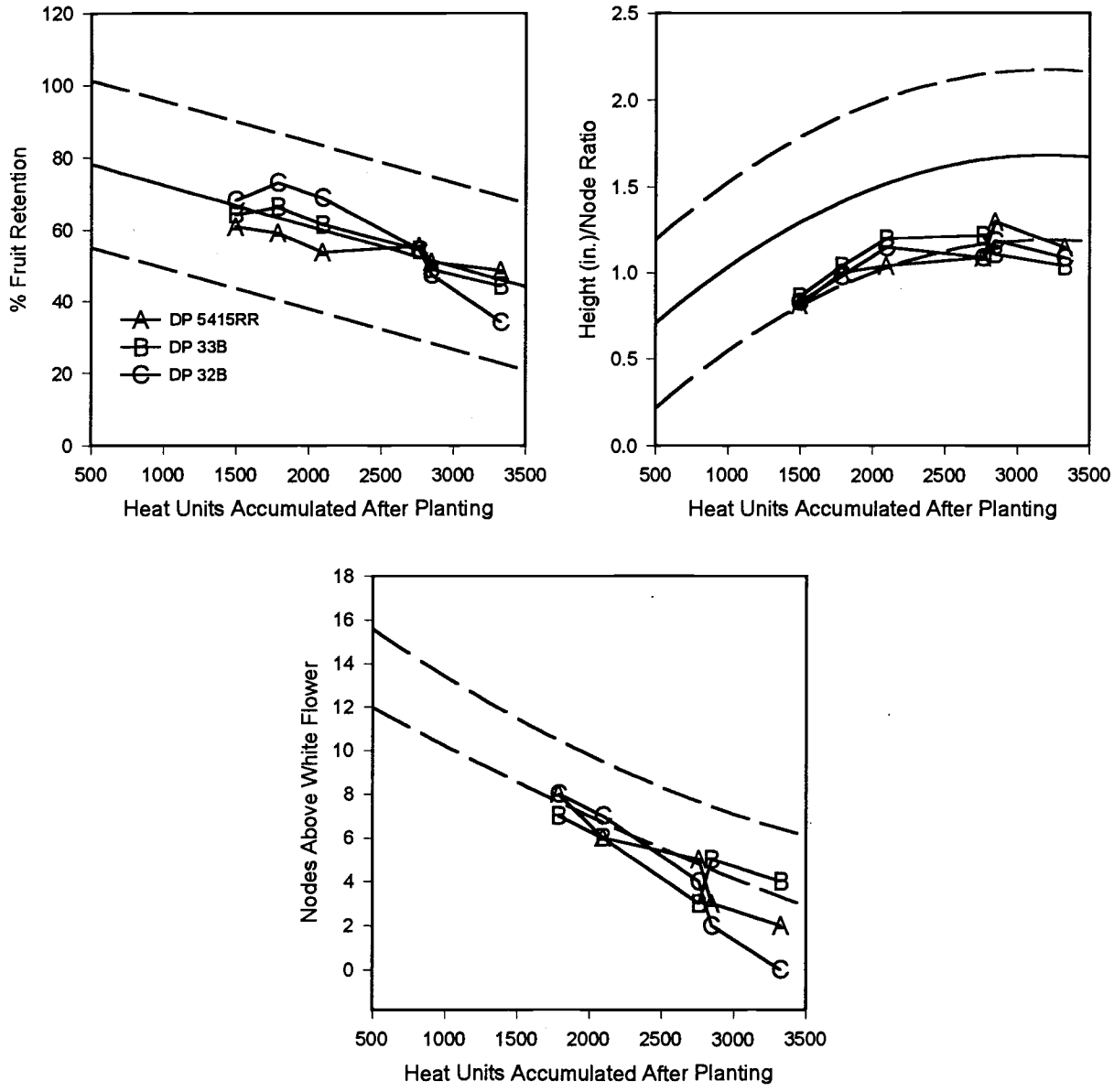

Figure 4. Plant growth and development comparisons for Bt vs. non-Bt varieties, Buckeye, AZ, 1997.

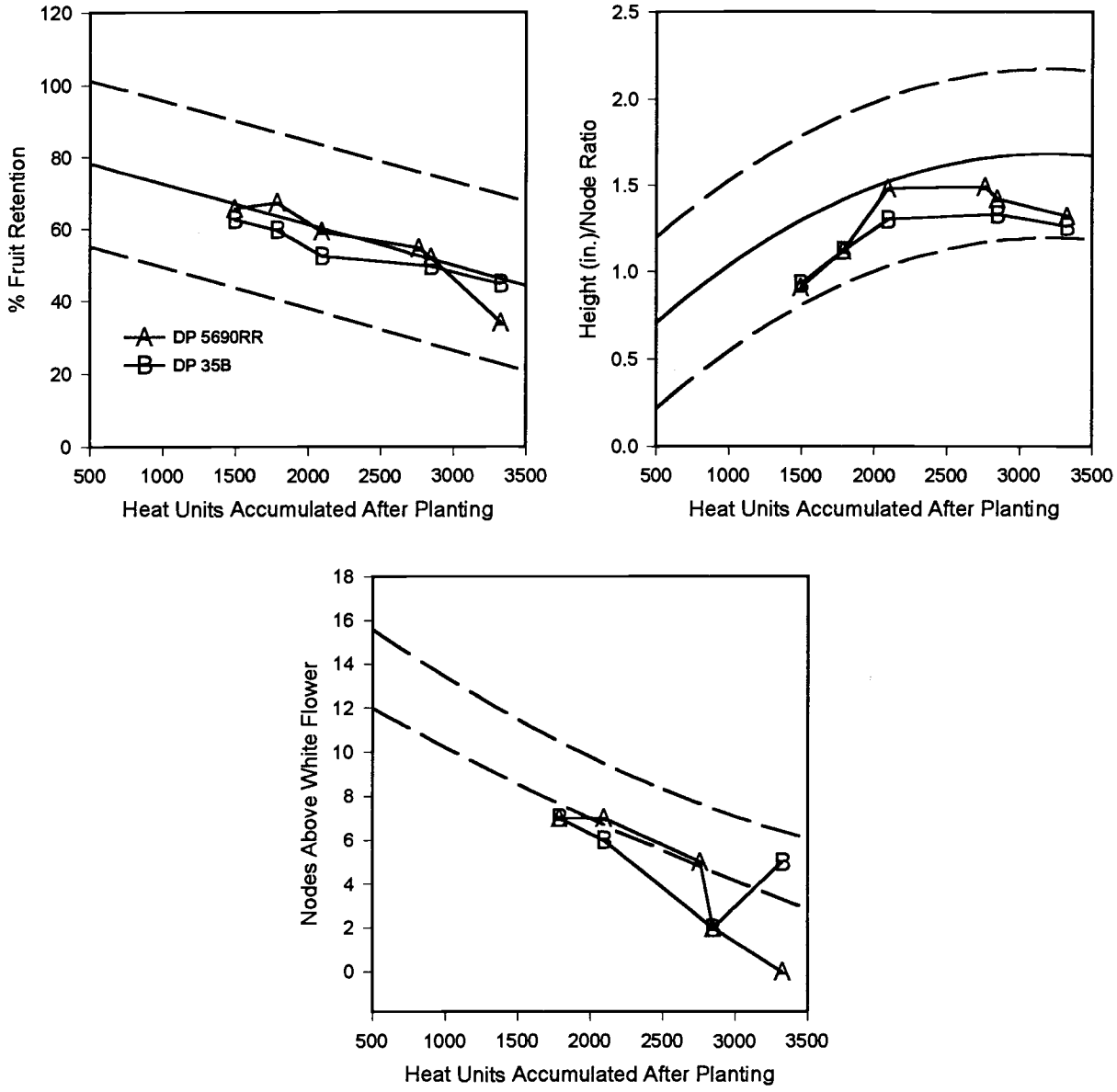

Figure 5. Plant growth and development comparisons for Bt vs. non-Bt varieties, Buckeye, AZ, 1997.

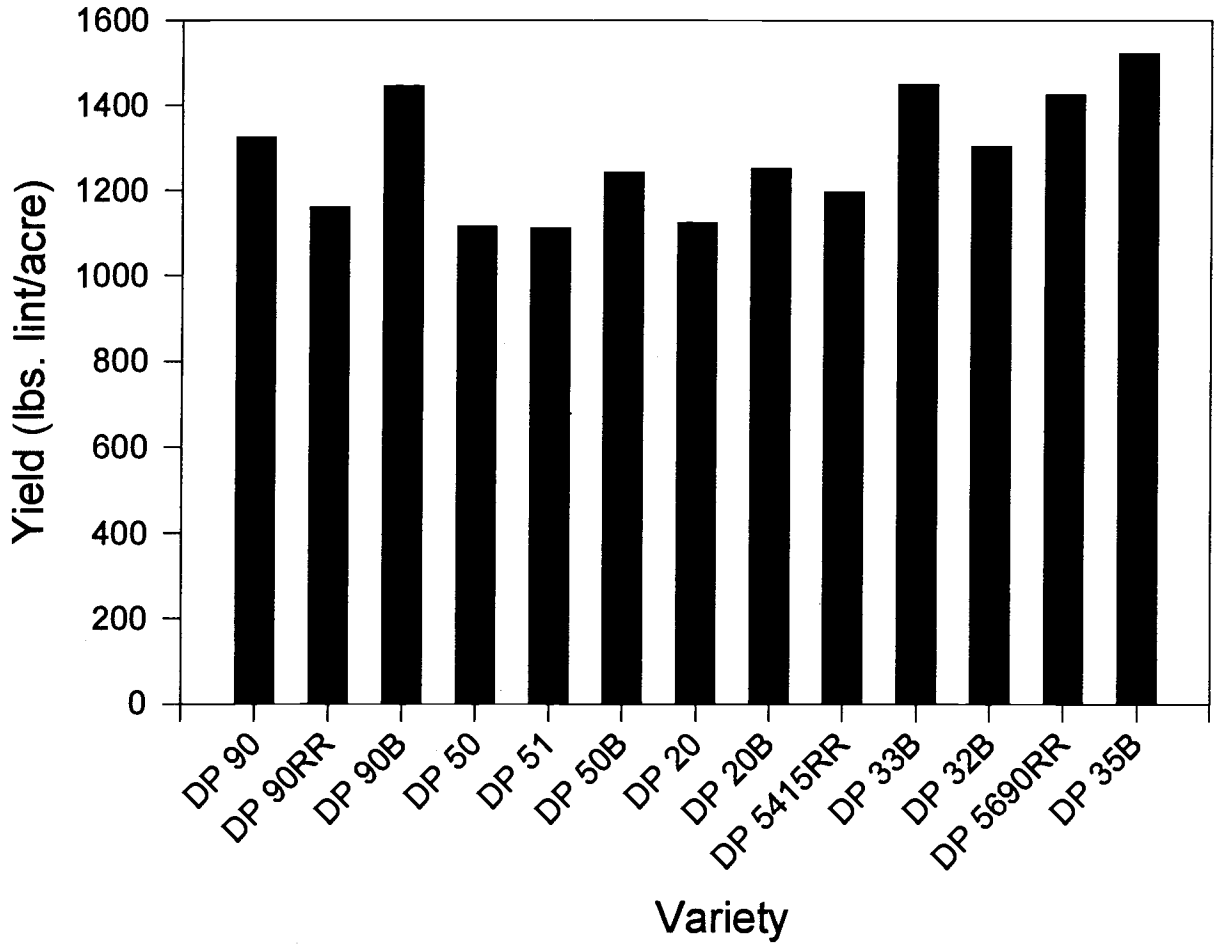

Figure 6. Yield comparisons for Bt vs. non-Bt varieties, Buckeye, AZ, 1997.

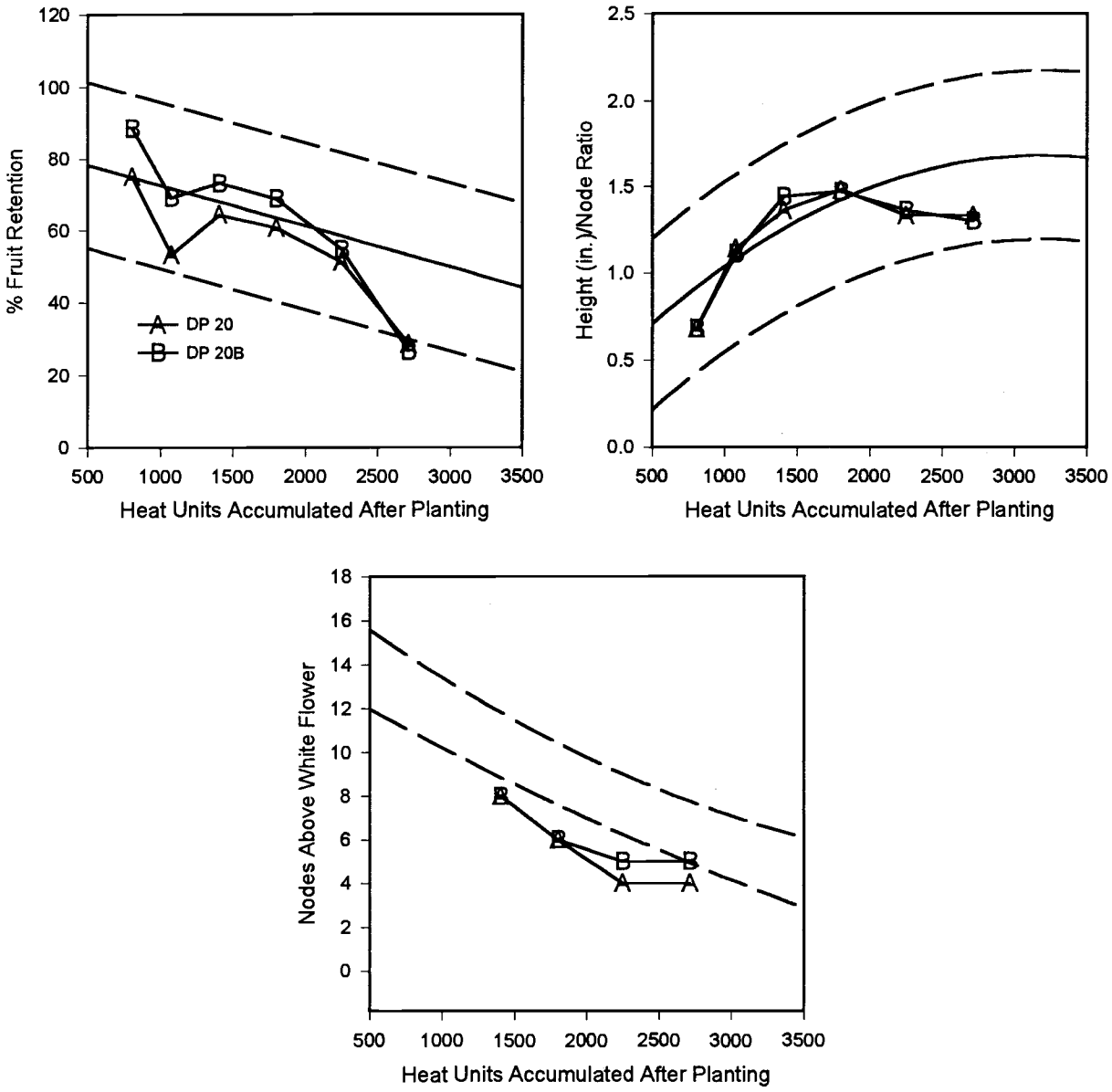

Figure 7. Plant growth and development comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997.

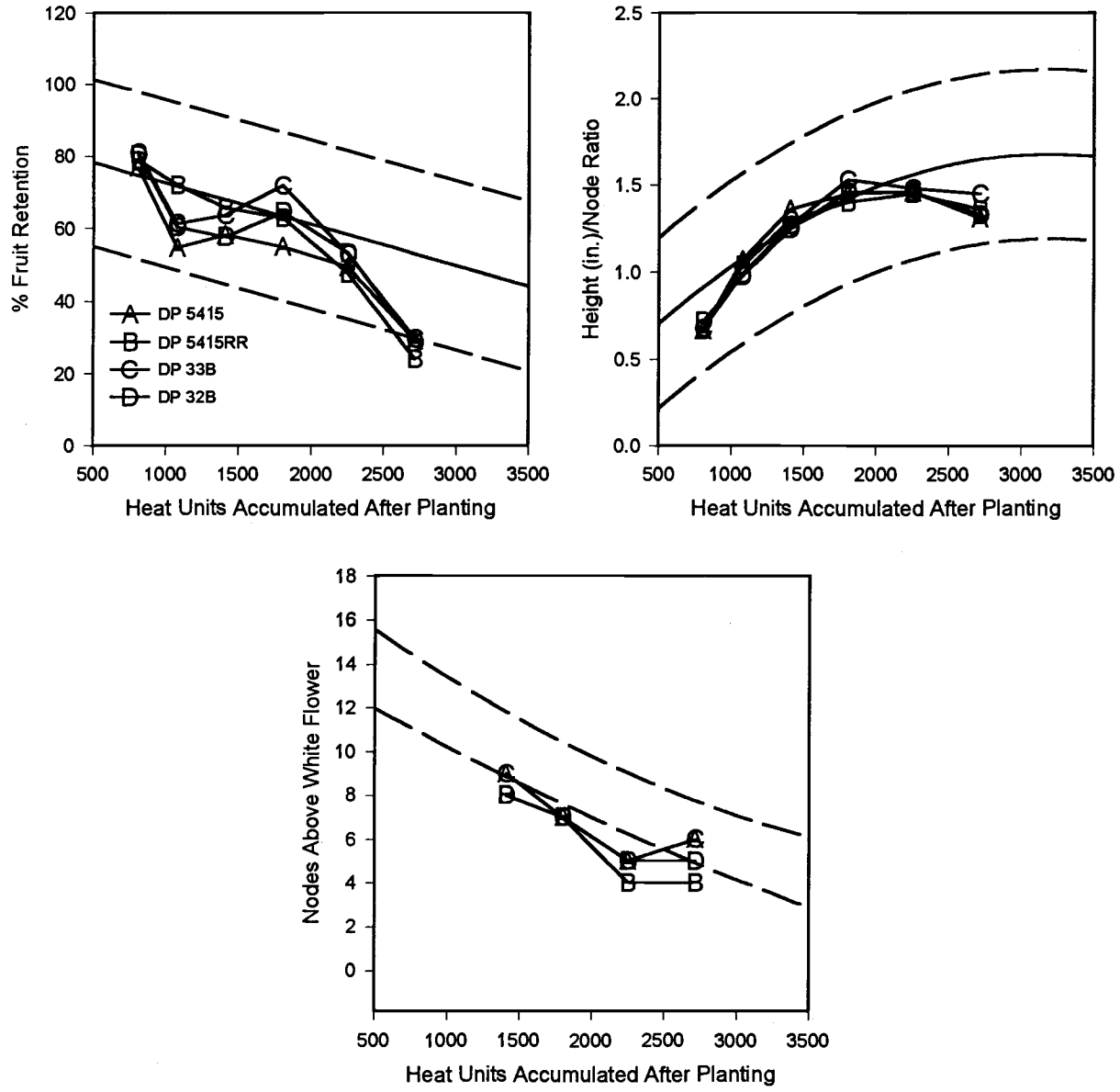

Figure 8. Plant growth and development comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997.

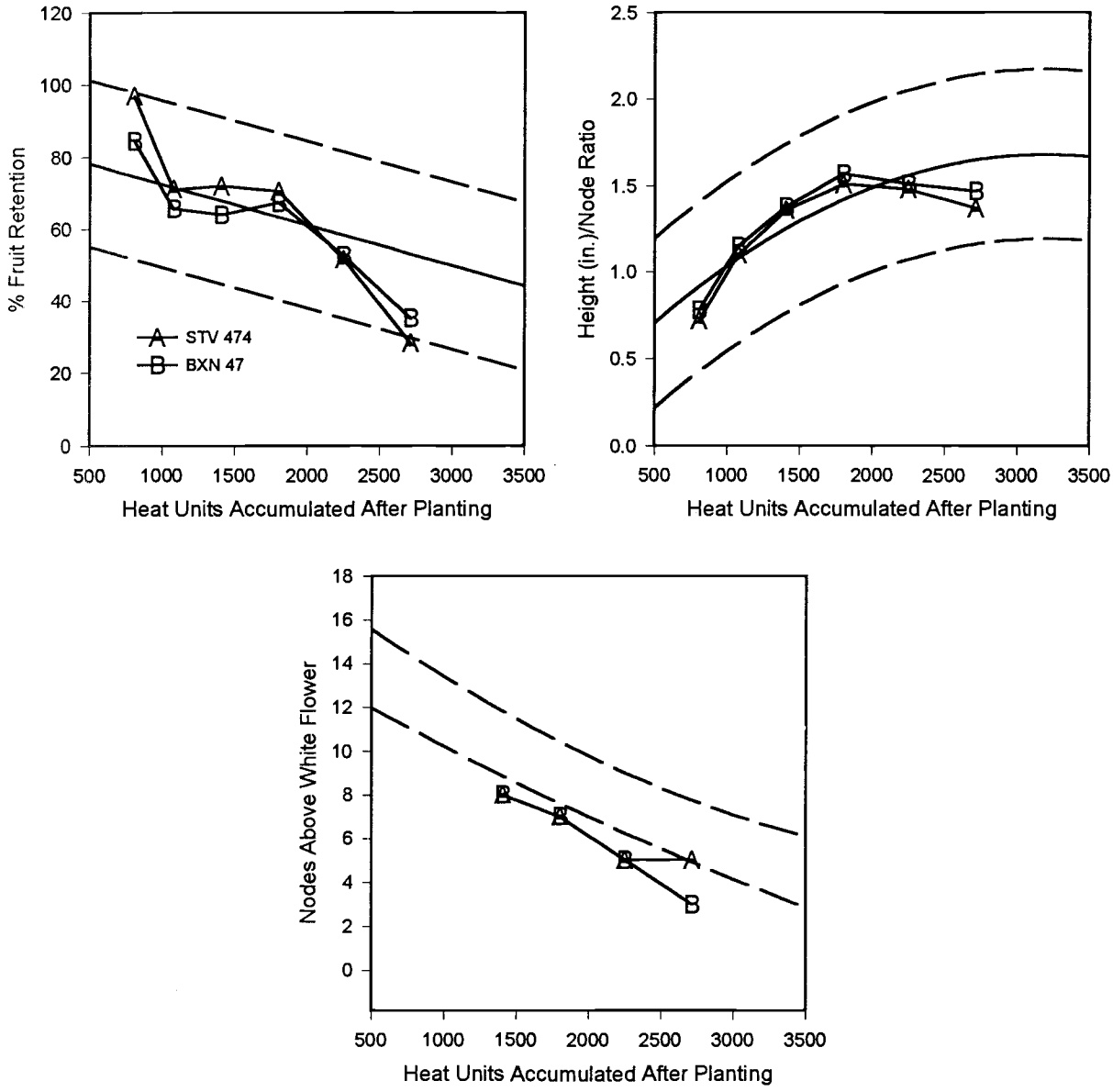

Figure 9. Plant growth and development comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997.

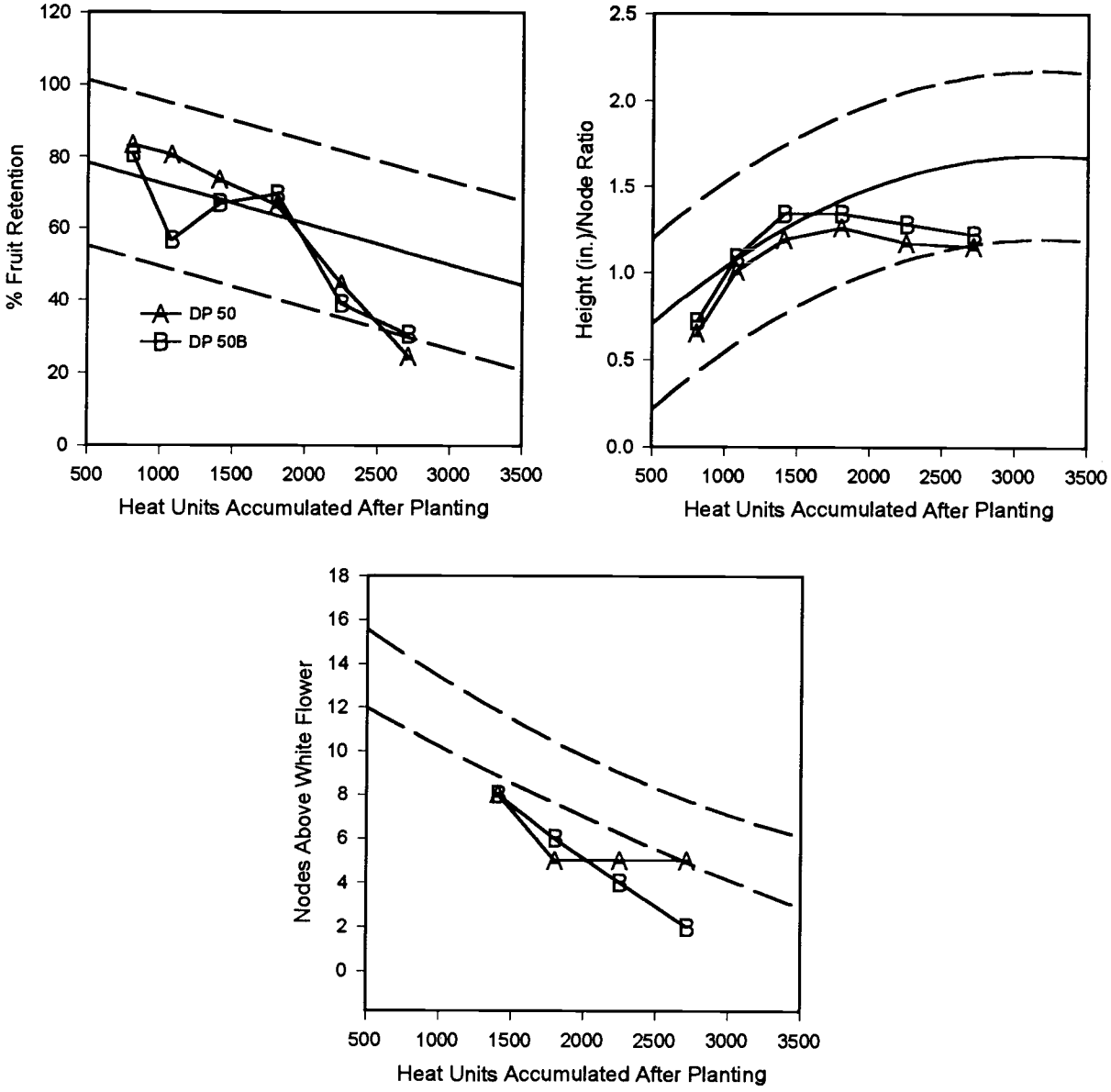

Figure 10. Plant growth and development comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997.

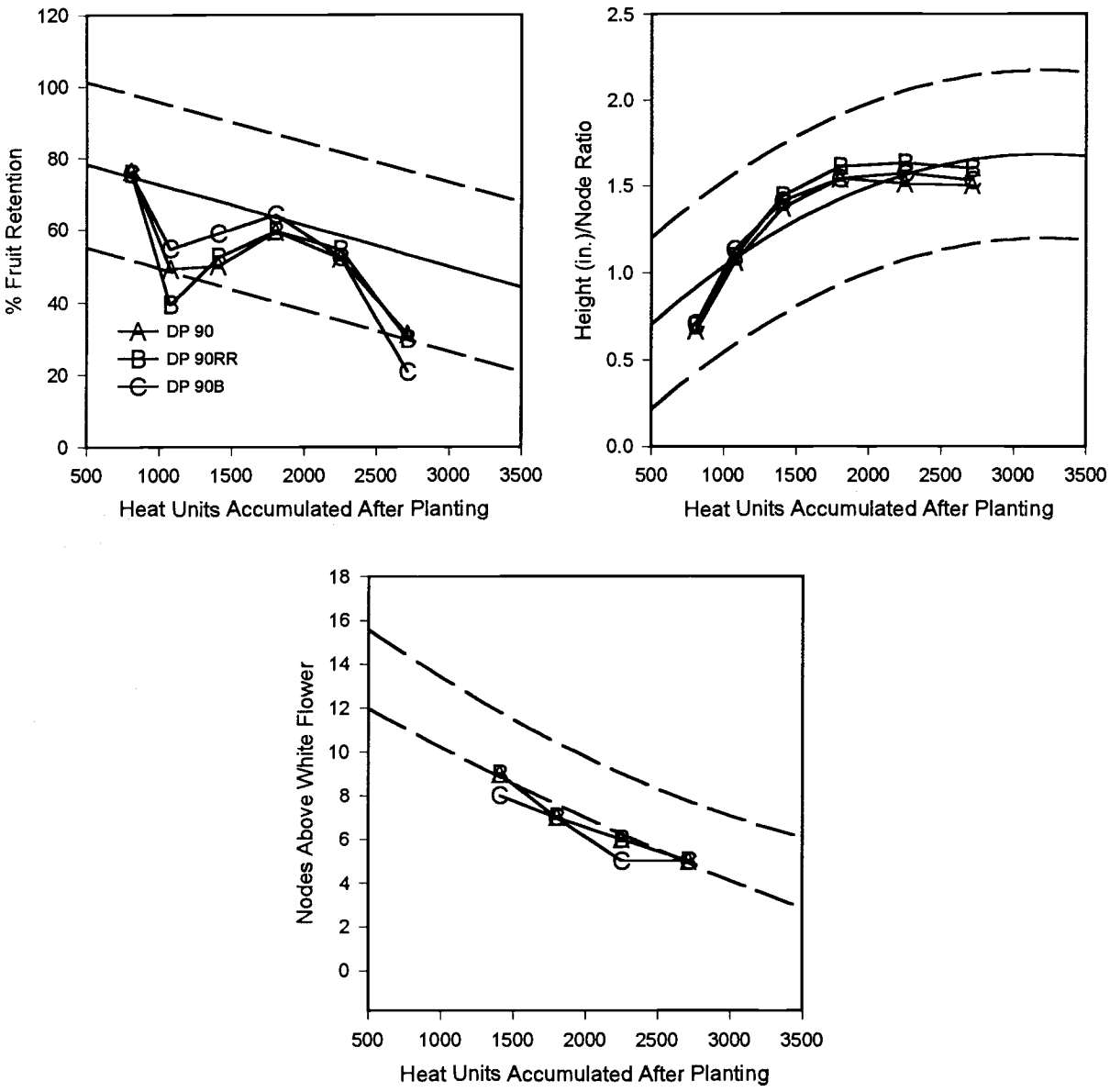

Figure 11. Plant growth and development comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997.

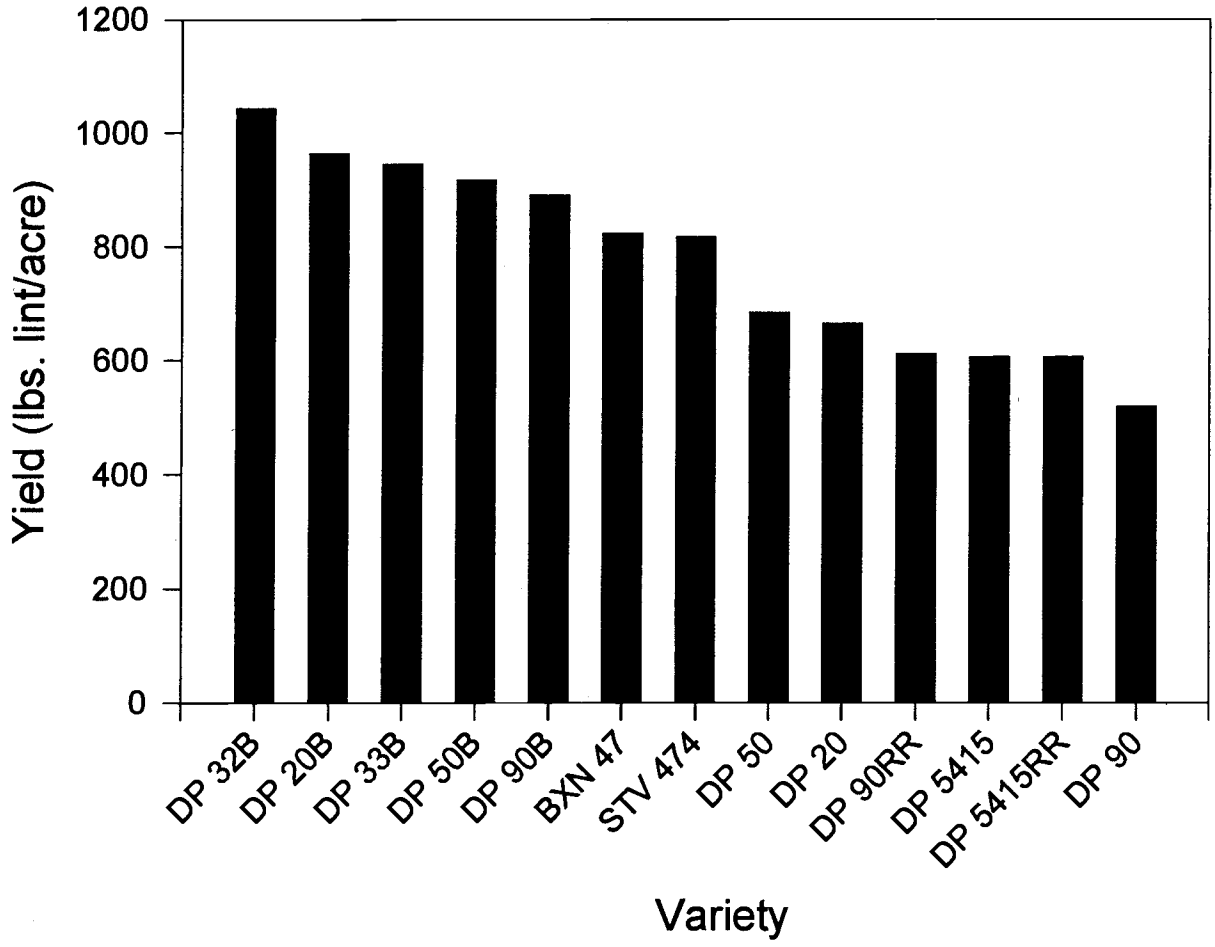

Figure 12. Yield comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997.

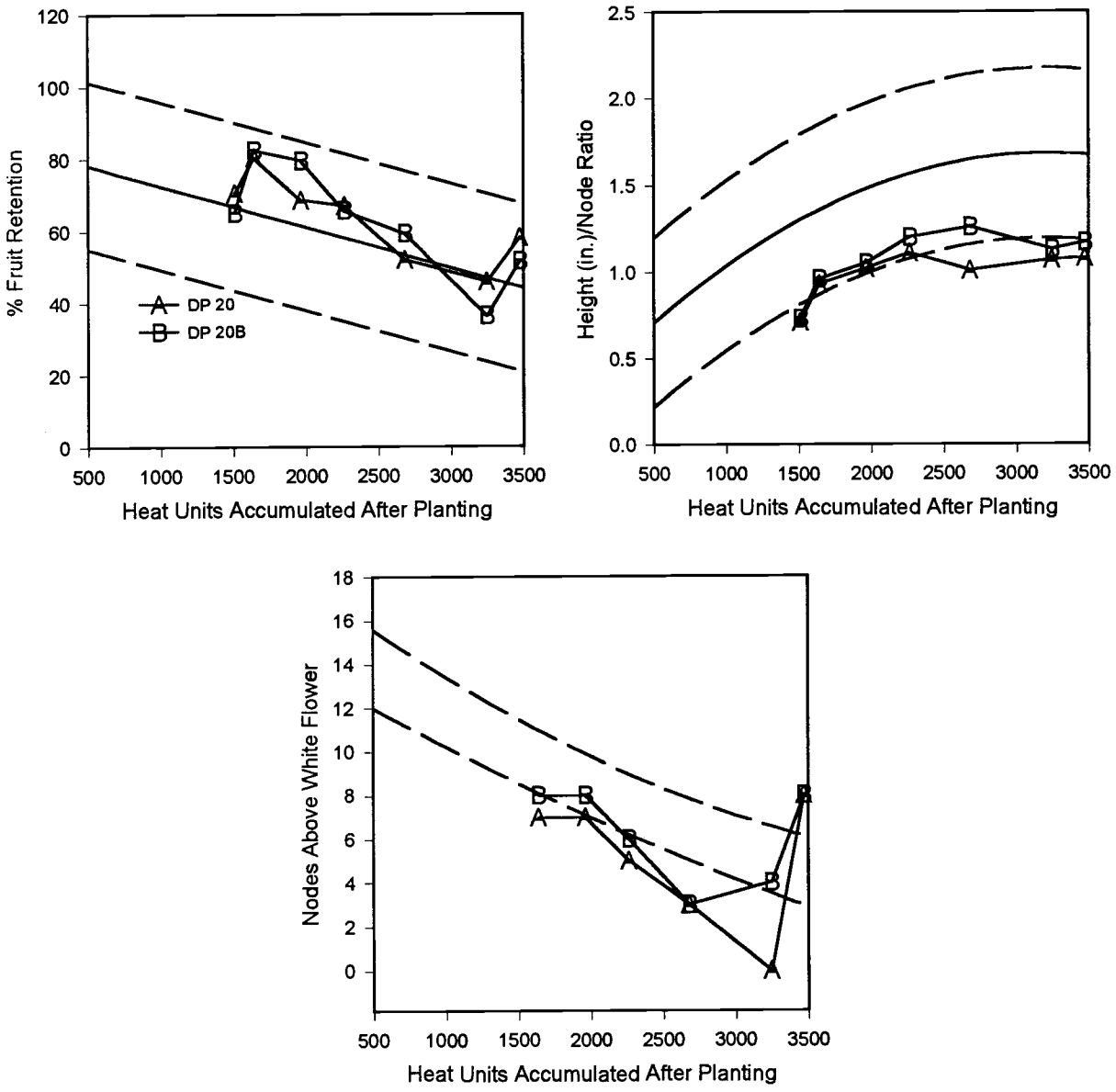

Figure 13. Plant growth and development comparisons for Bt vs. non-Bt varieties, Paloma Ranch, AZ, 1997.

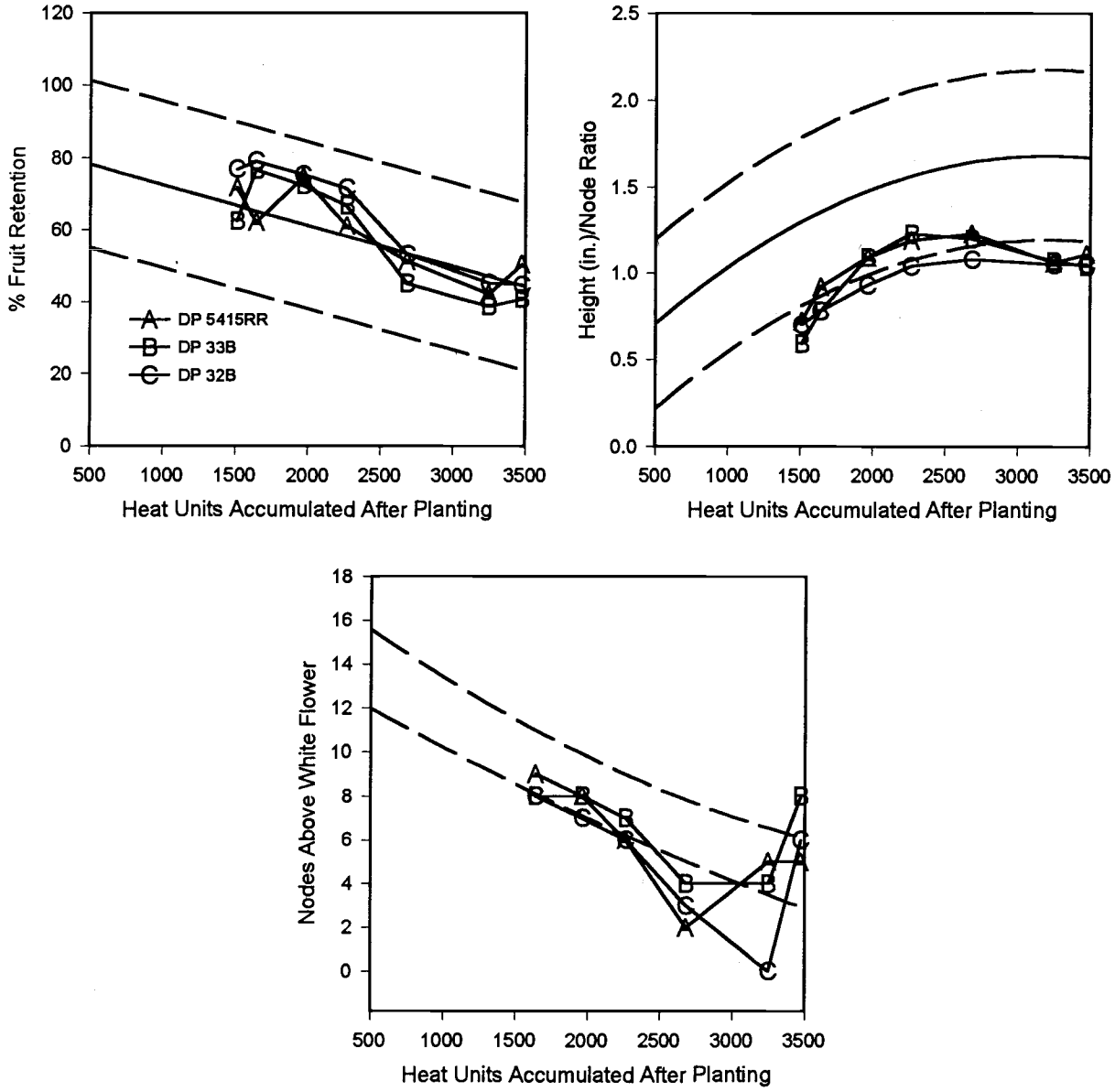

Figure 14. Plant growth and development comparisons for Bt vs. non-Bt varieties, Paloma Ranch, AZ, 1997.

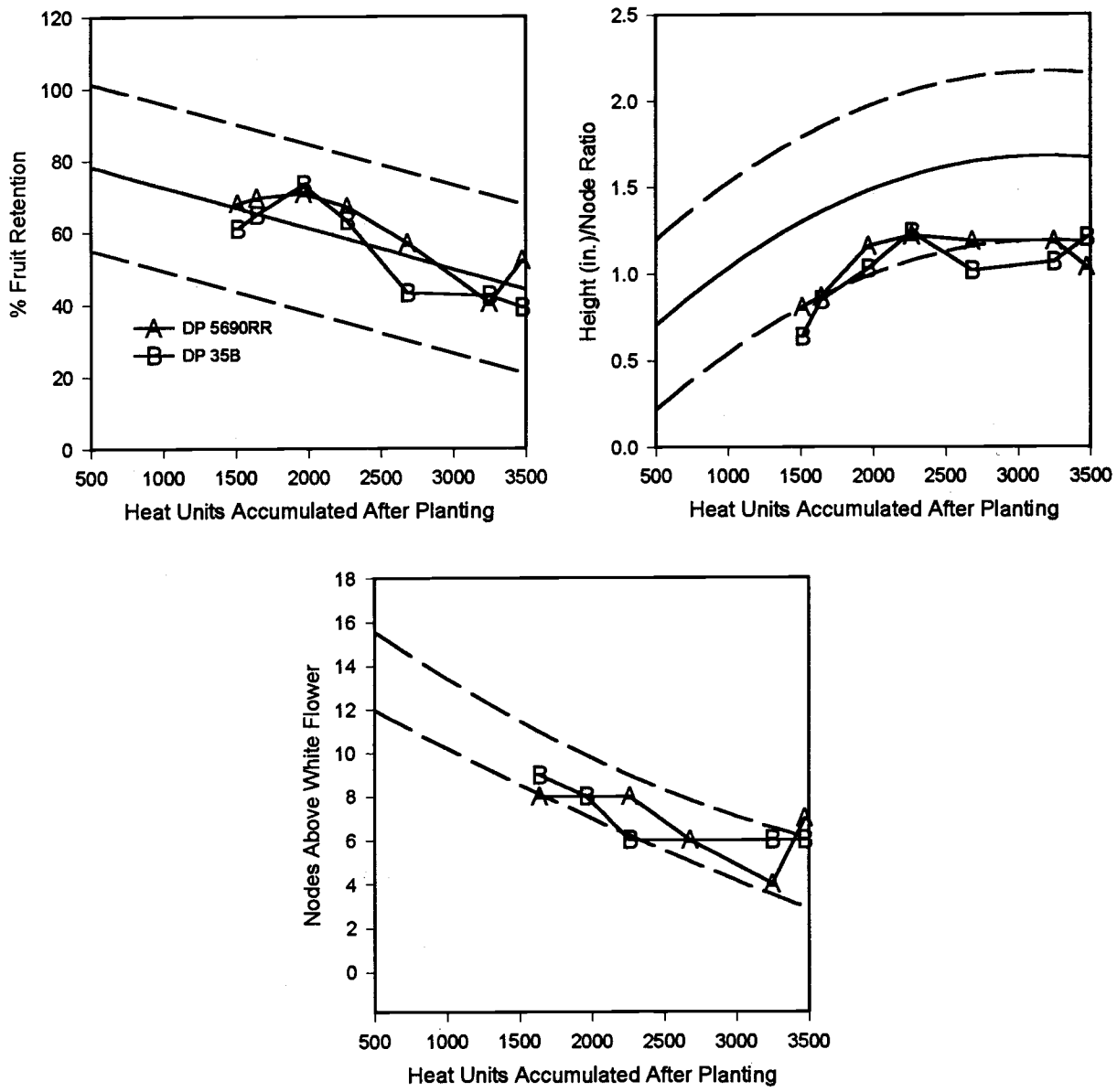

Figure 15. Plant growth and development comparisons for Bt vs. non-Bt varieties, Paloma Ranch, AZ, 1997.

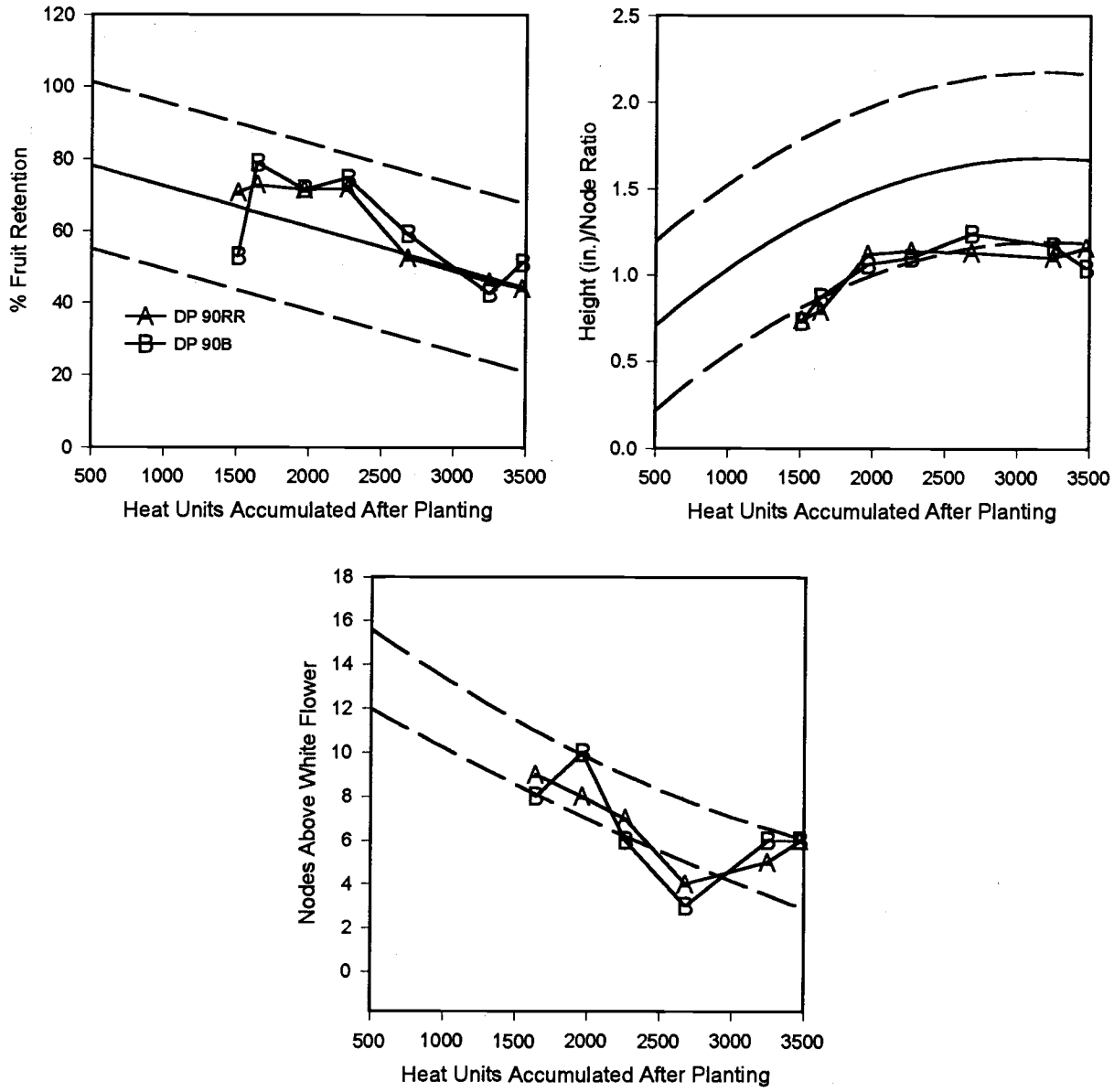

Figure 16. Plant growth and development comparisons for Bt vs. non-Bt varieties, Paloma Ranch, AZ, 1997.

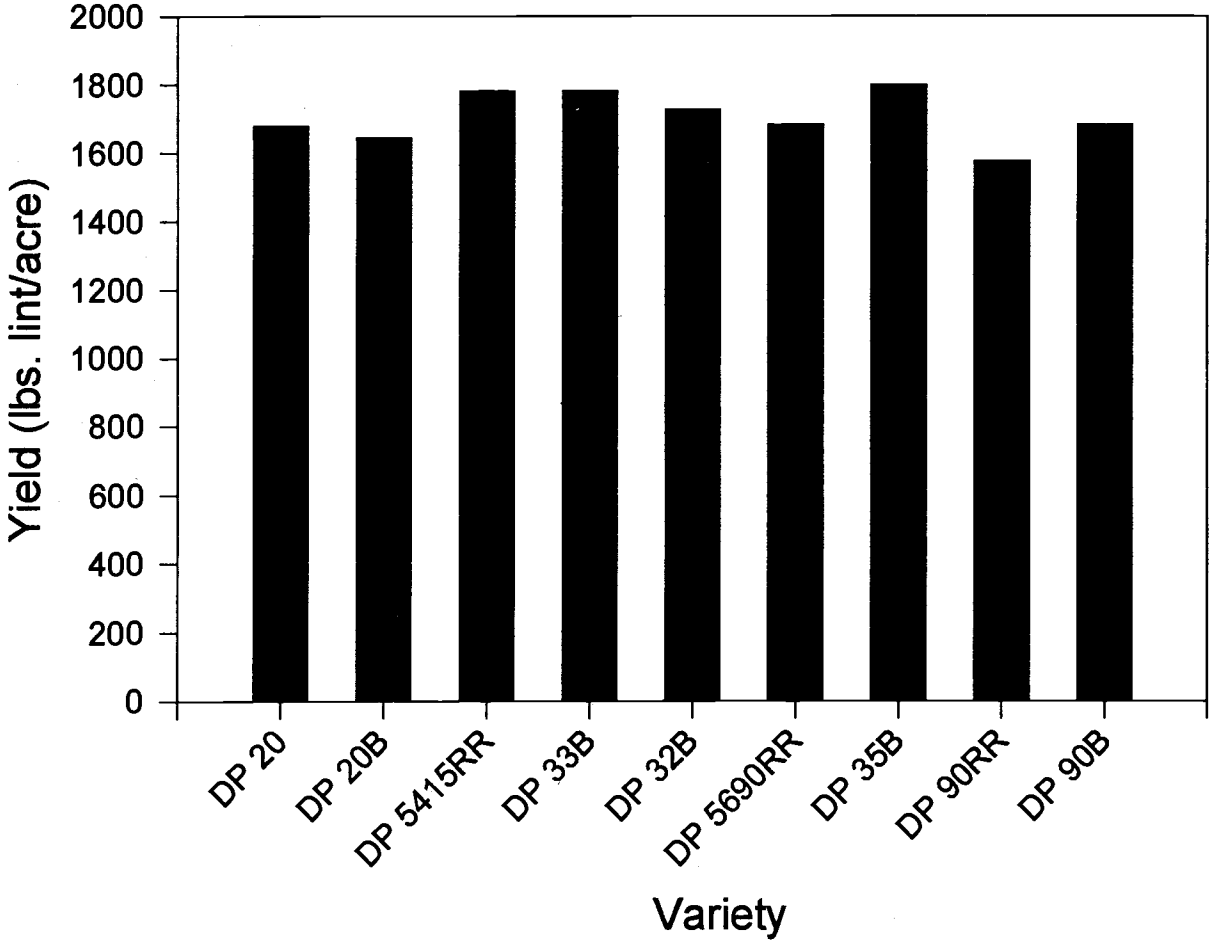

Figure 17. Yield comparisons for Bt vs. non-Bt varieties, Paloma Ranch, AZ, 1997.

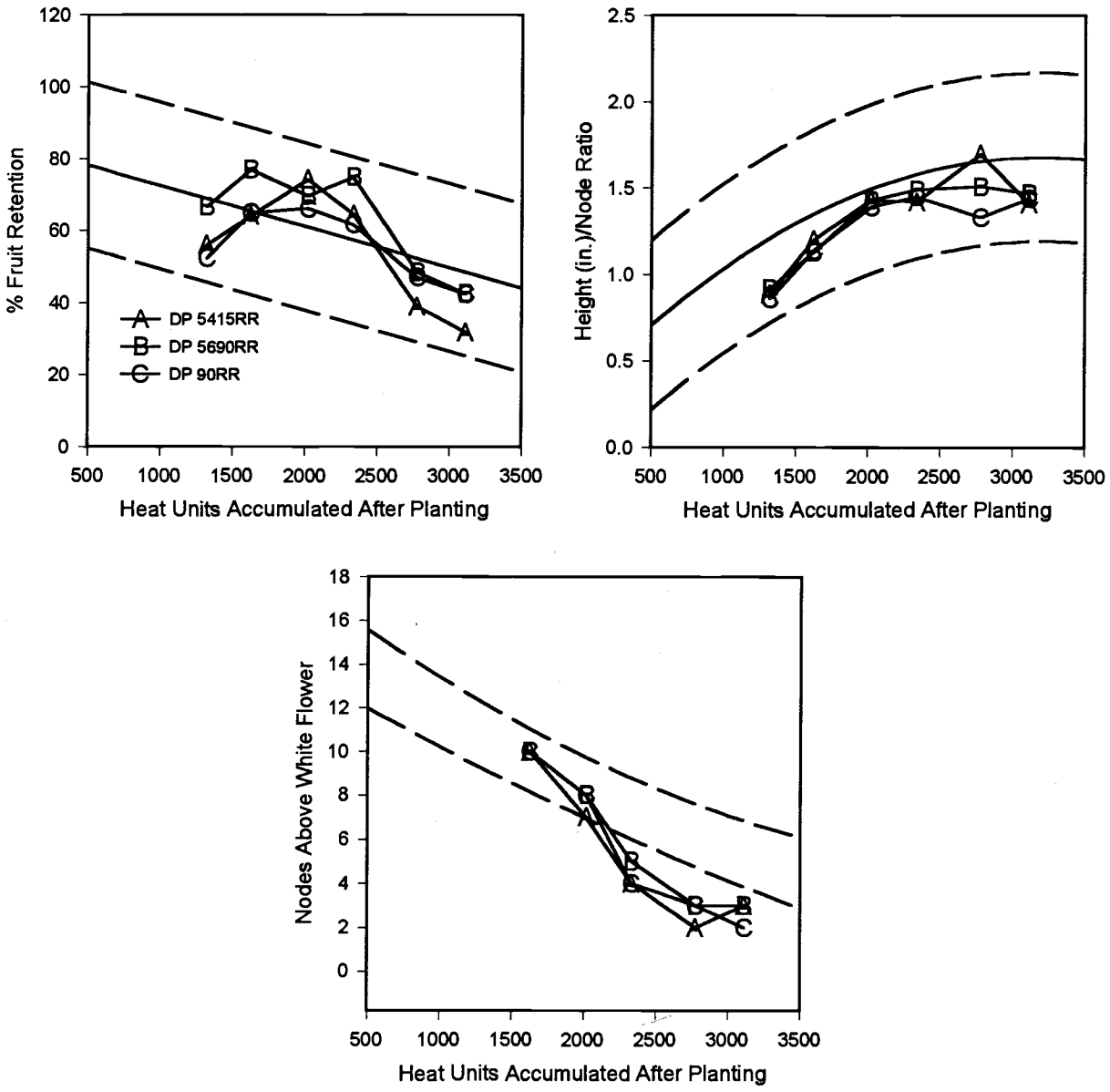

Figure 18. Plant growth and development comparisons for Bt vs. non-Bt varieties, Casa Grande, AZ, 1997.

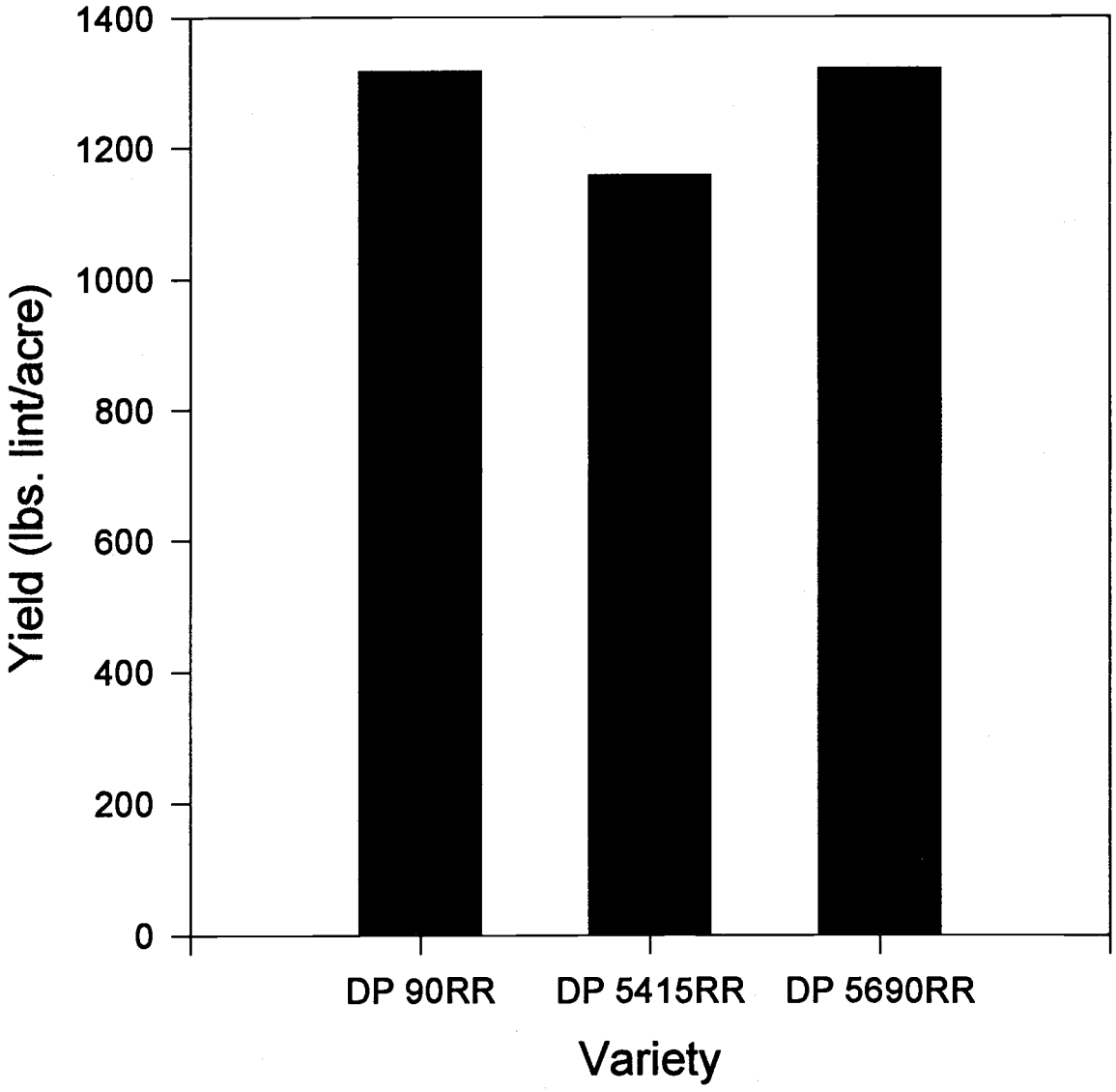

Figure 19. Yield comparisons for Bt vs. non-Bt varieties, Casa Grande, AZ, 1997.

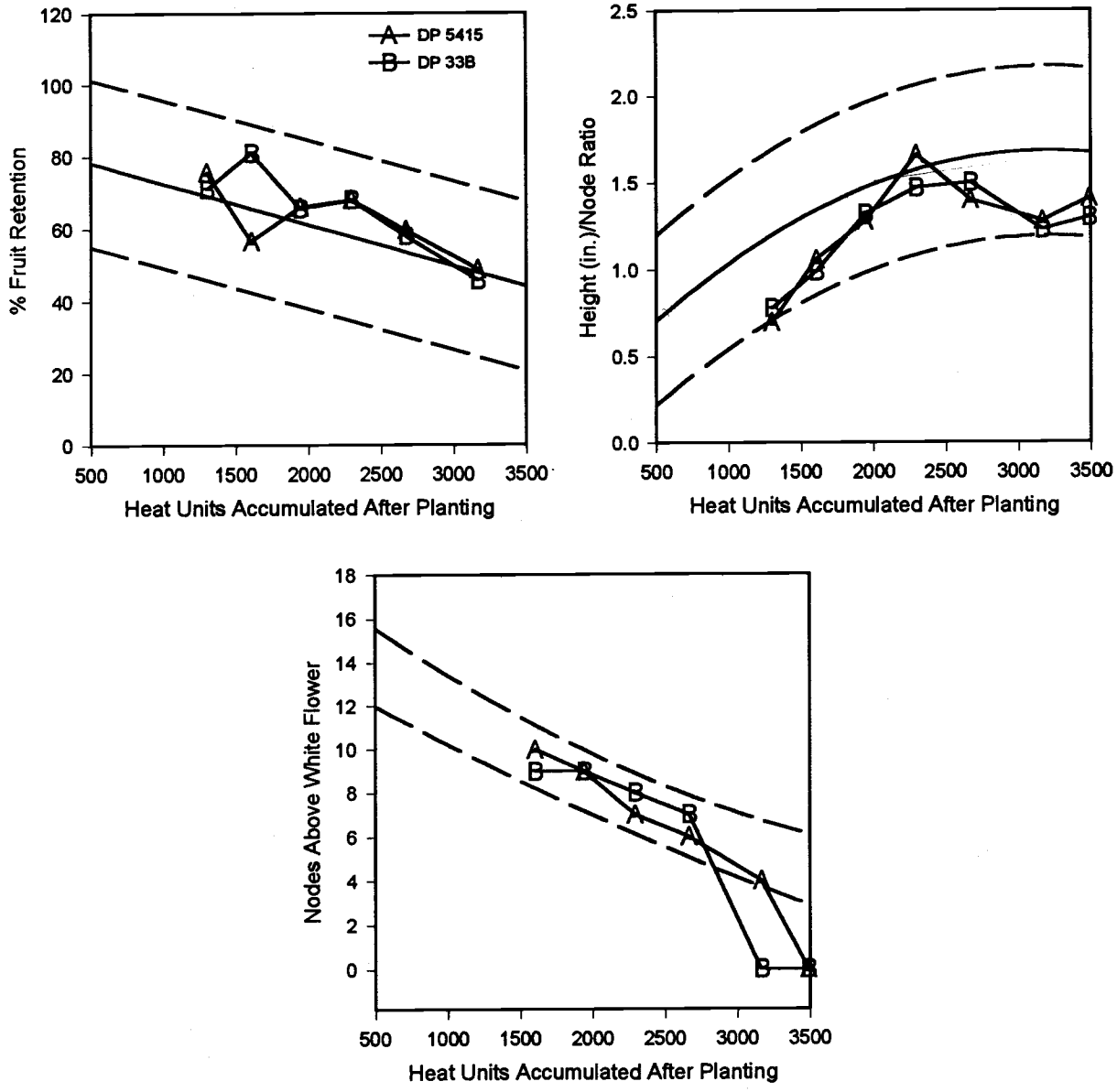

Figure 20. Plant growth and development comparisons for Bt vs. non-Bt varieties, Maricopa, AZ, 1997 (Planting Date by Variety Study, PD1=13 March, 312 HU/Jan. 1).

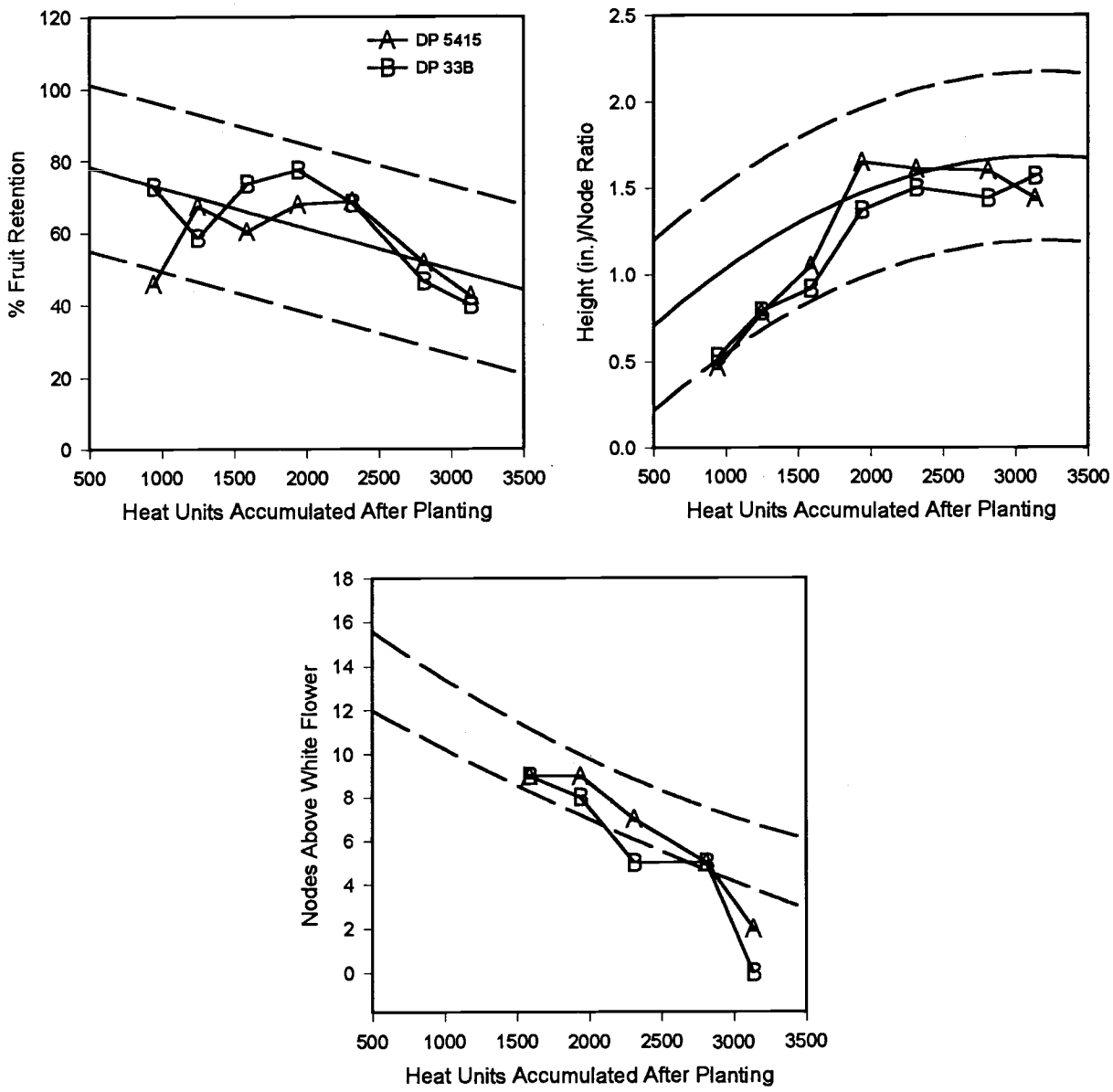

Figure 21. Plant growth and development comparisons for Bt vs. non-Bt varieties, Maricopa, AZ, 1997 (Planting Date by Variety Study, PD2=9 April, 668 HU/Jan. 1).

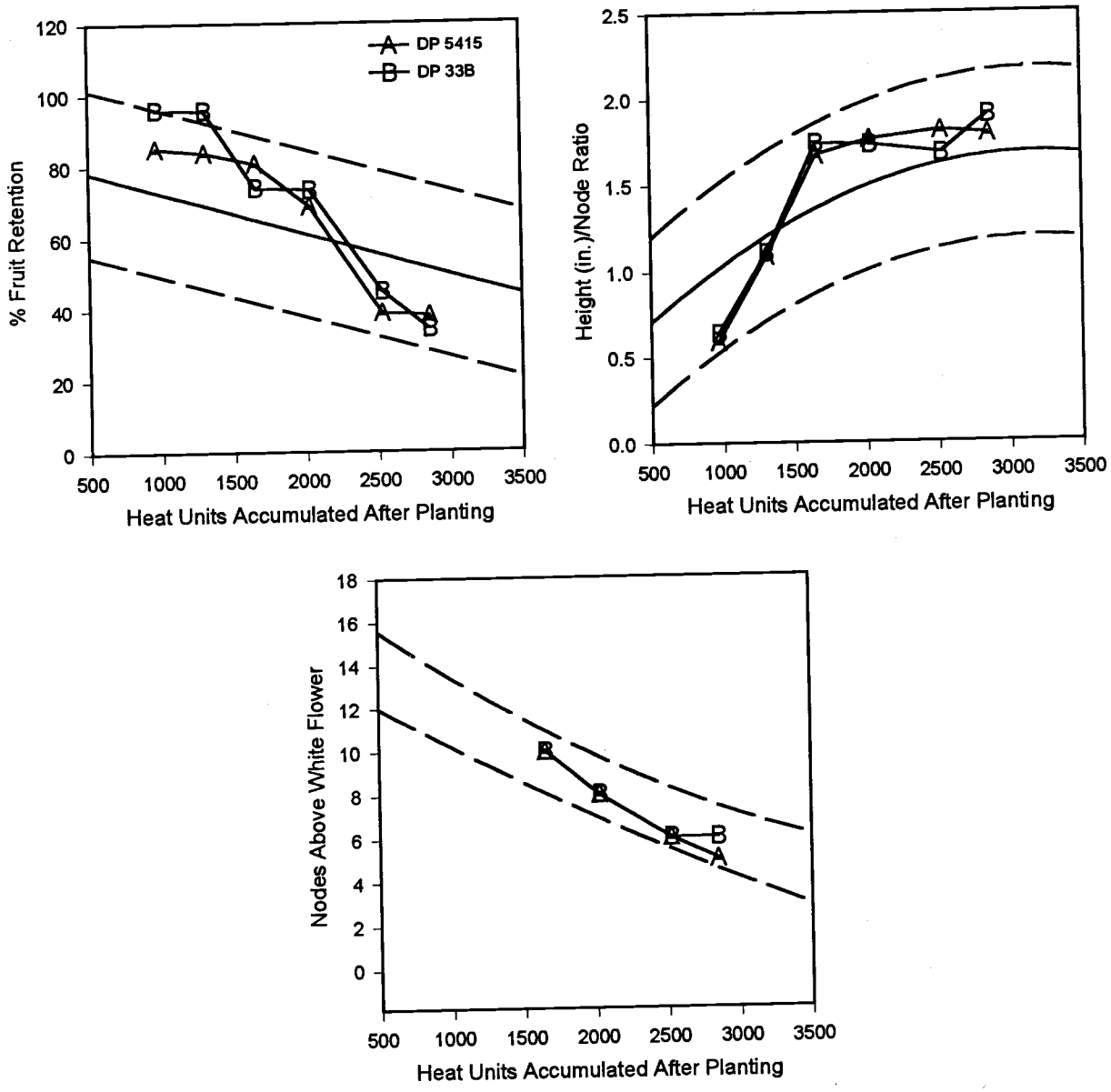

Figure 22. Plant growth and development comparisons for Bt vs. non-Bt varieties, Maricopa, AZ, 1997 (Planting Date by Variety Study, PD3=30 April, 951 HU/Jan. 1).

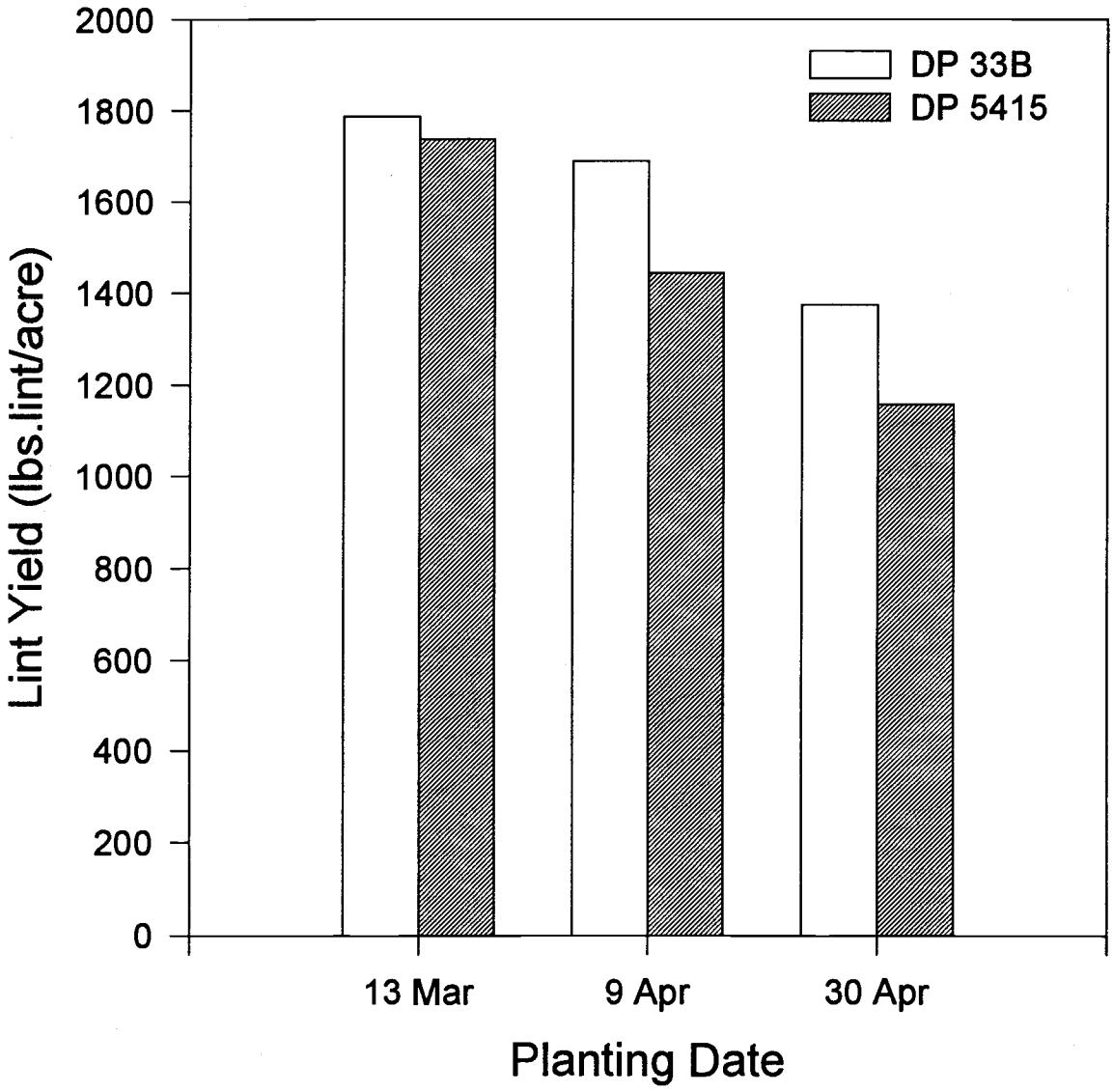

Figure 23. Yield comparisons for Bt vs. non-Bt varieties, Maricopa, AZ, 1997 (Planting Date by Variety Study).

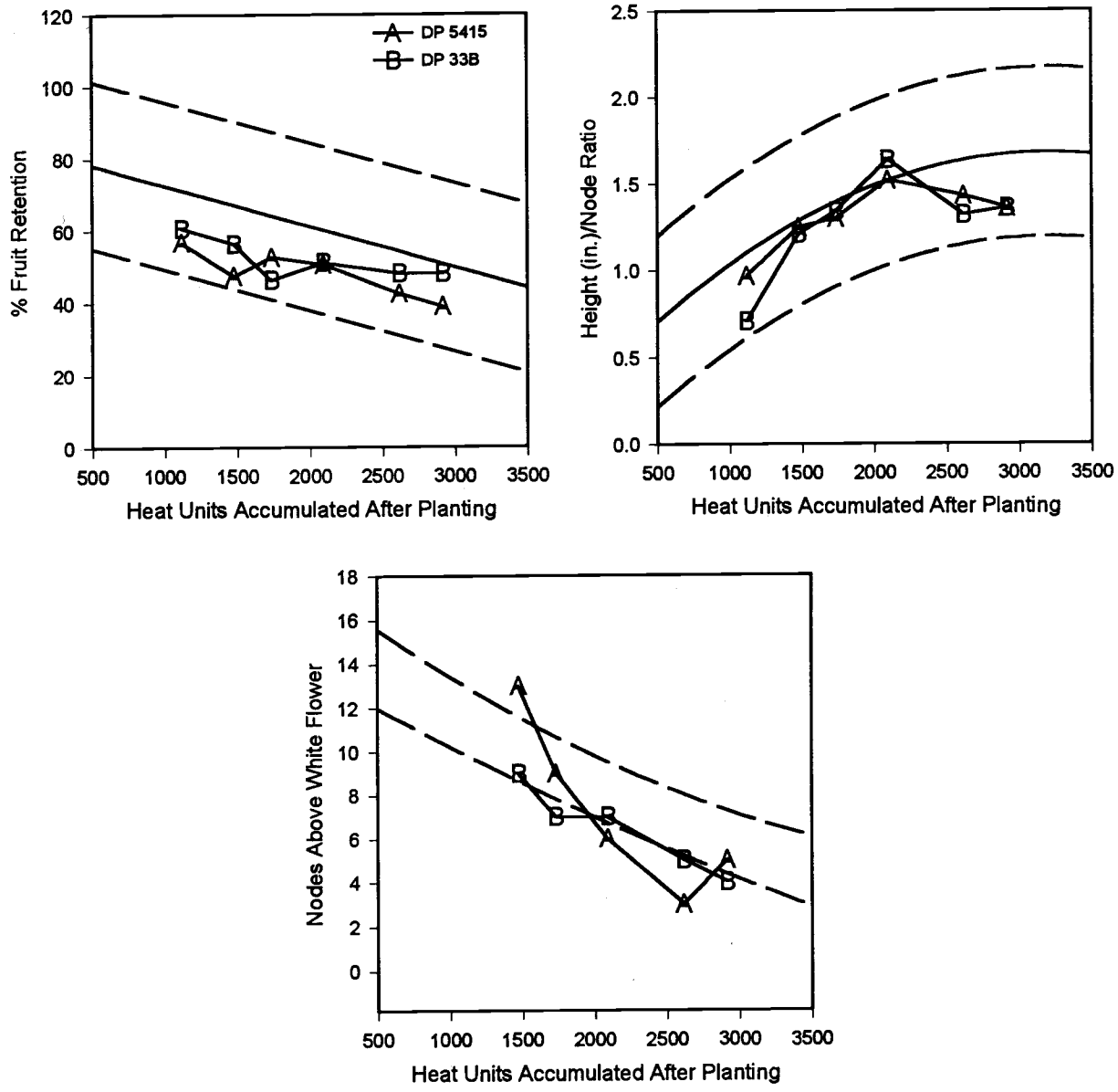

Figure 24. Plant growth and development comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997 (Planting Date by Variety Study, PD1=28 March, 469 HU/Jan. 1).

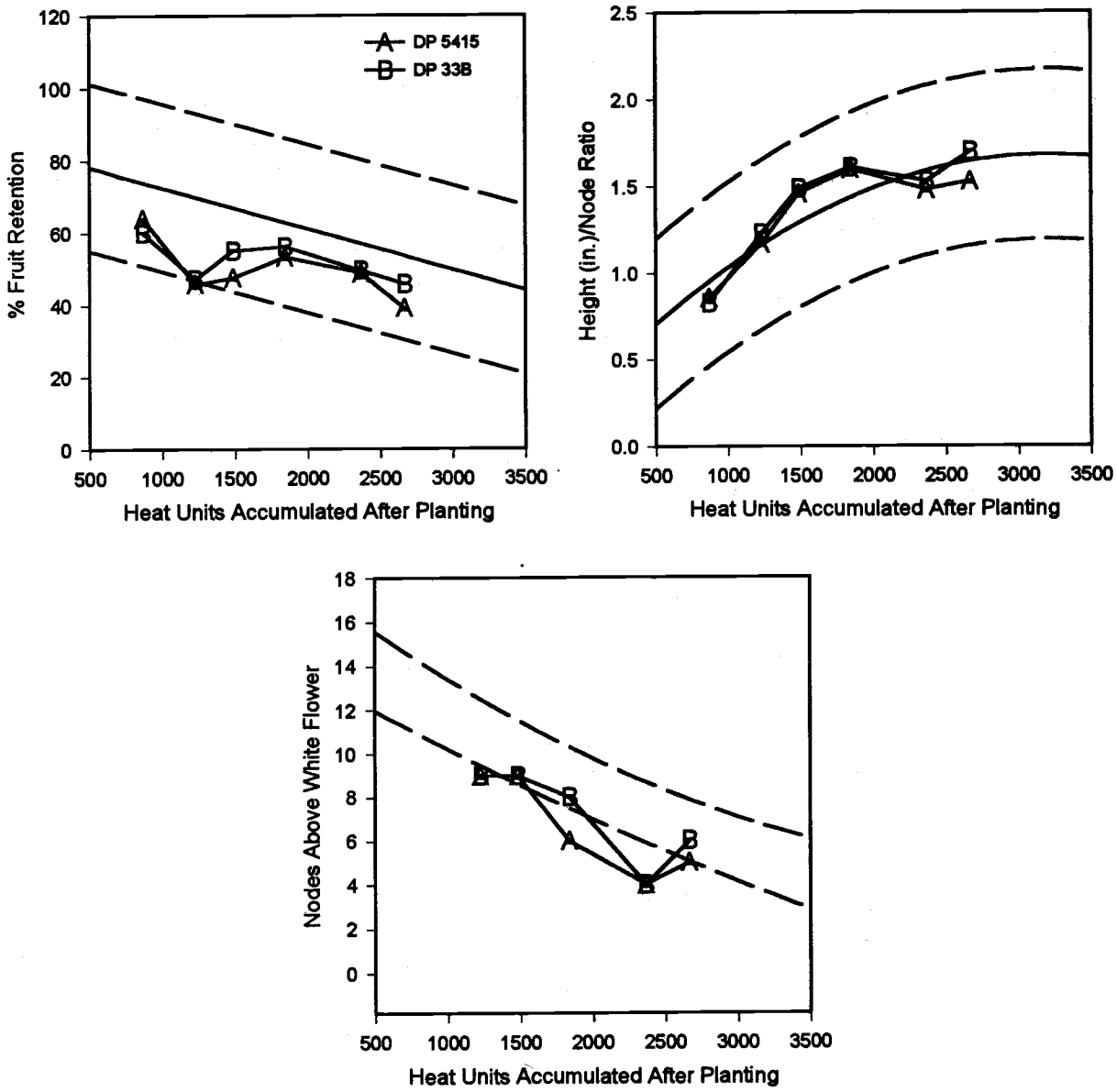

Figure 25. Plant growth and development comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997 (Planting Date by Variety Study, PD2=17 April, 717 HU/Jan. 1).

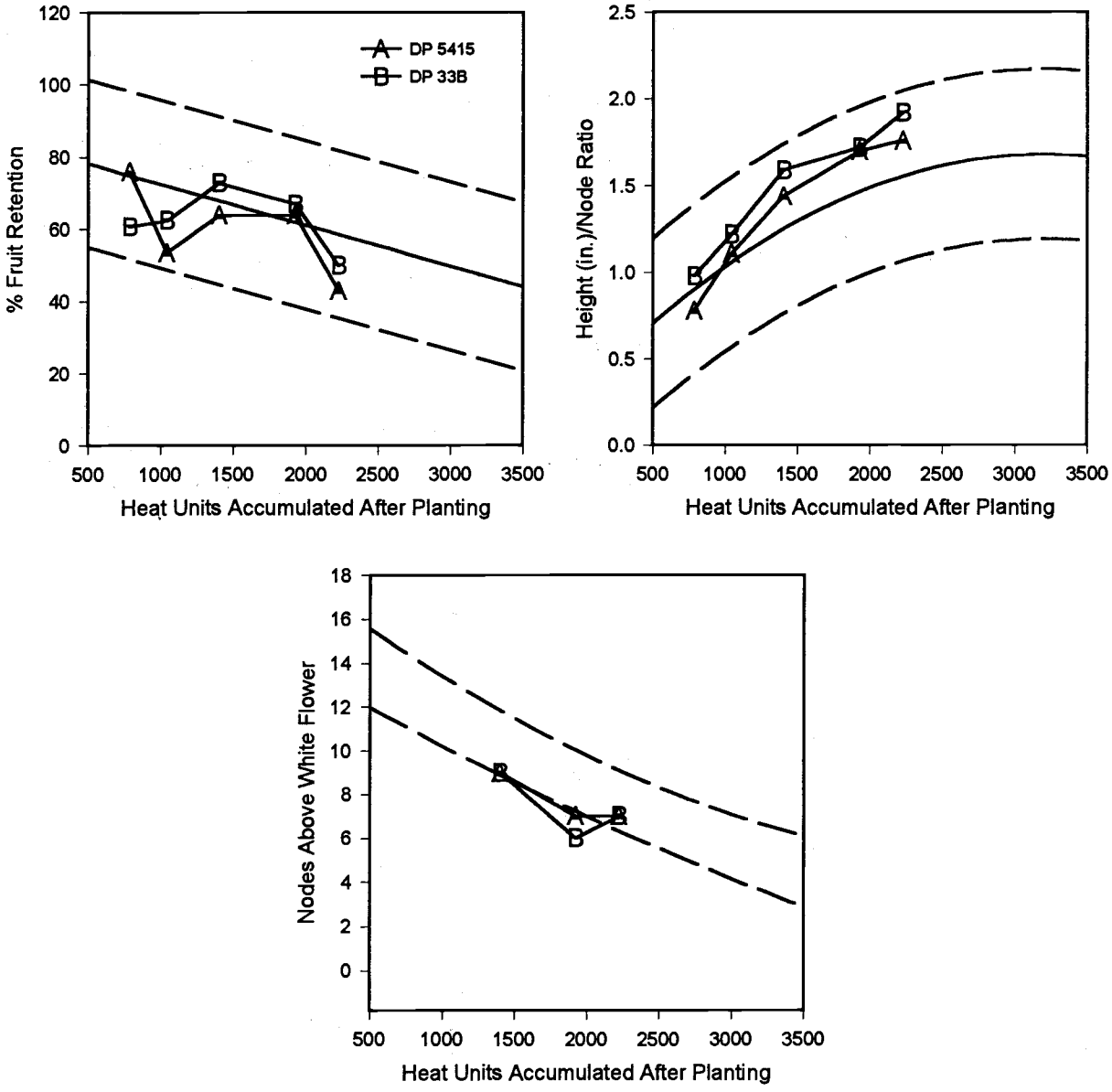

Figure 26. Plant growth and development comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997 (Planting Date by Variety Study, PD3=8 May, 1159 HU/Jan. 1).

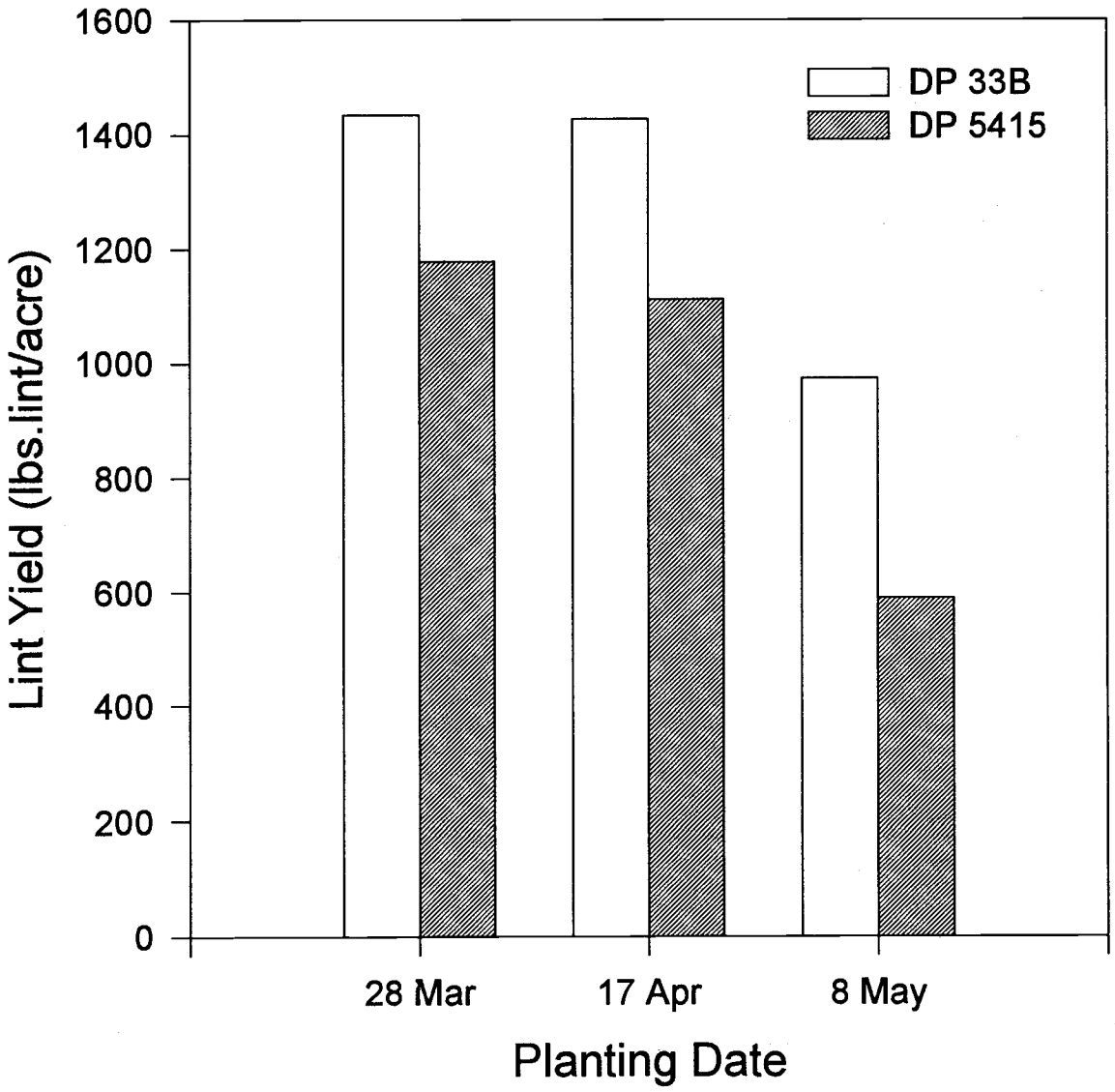

Figure 27. Yield comparisons for Bt vs. non-Bt varieties, Marana, AZ, 1997 (Planting Date by Variety Study).

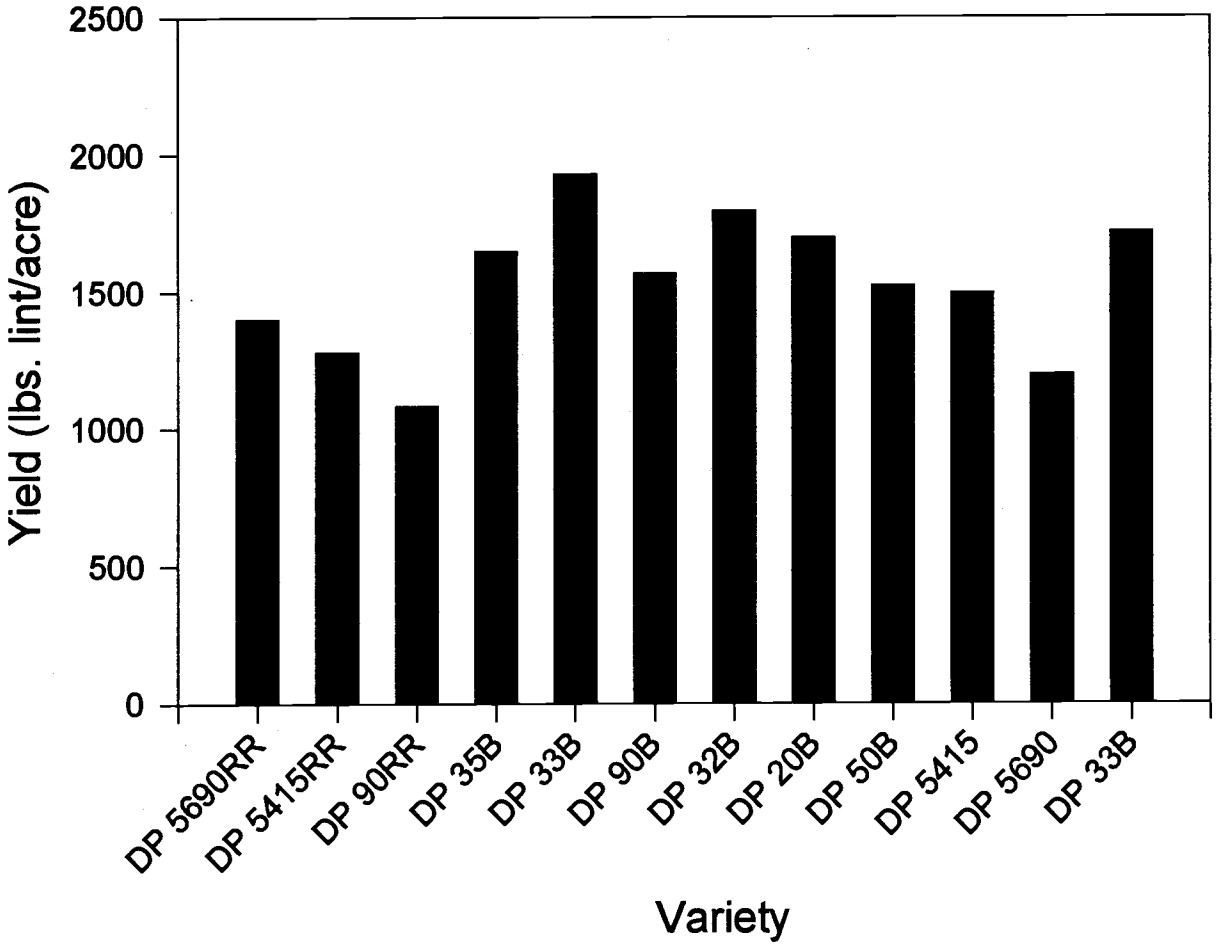

Figure 28. Yield comparisons for Bt vs. non-Bt varieties, Maricopa, AZ, 1997 (Rancho Pobre).

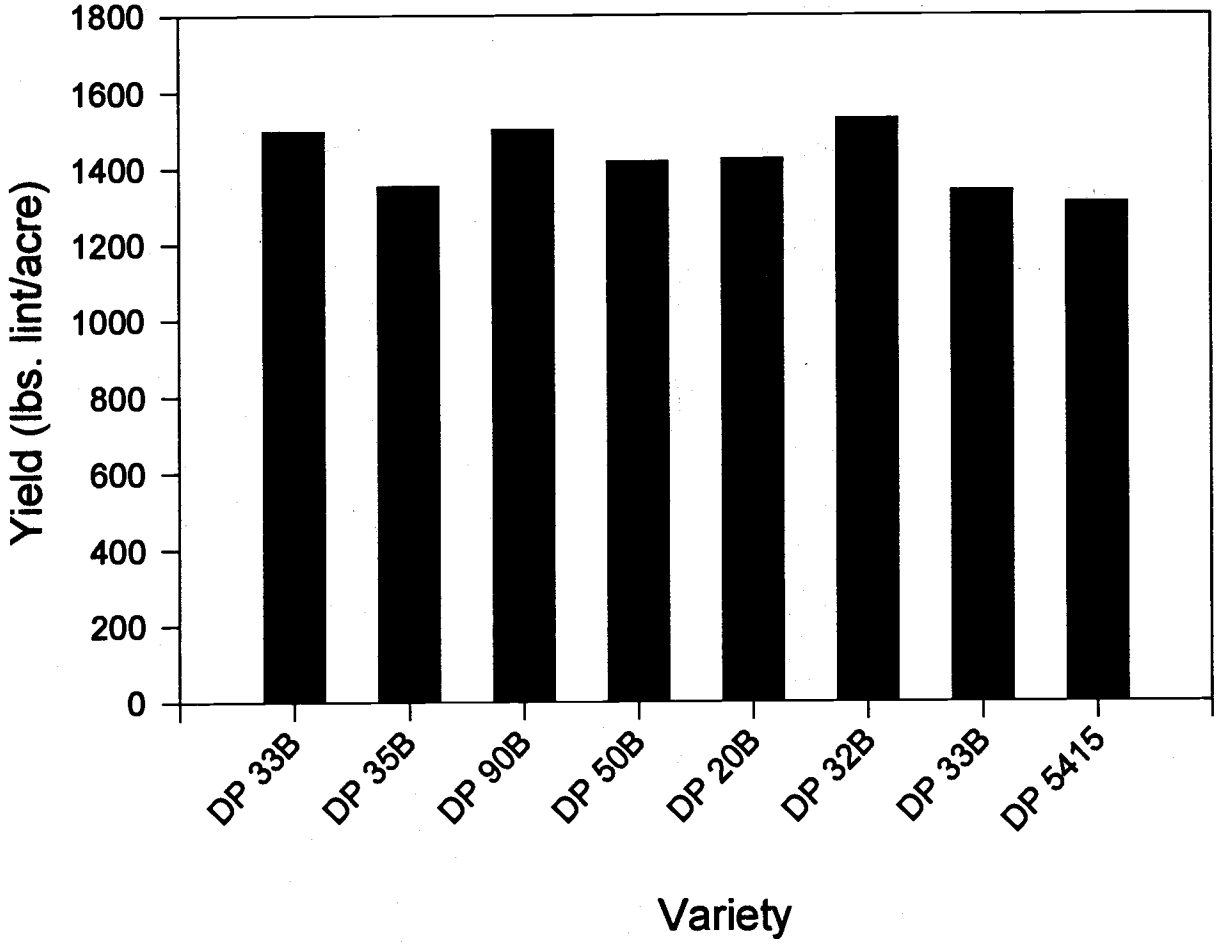

Figure 29. Yield comparisons for Bt vs. non-Bt varieties, Tolleson, AZ, 1997 (The Accomazzo Co.).

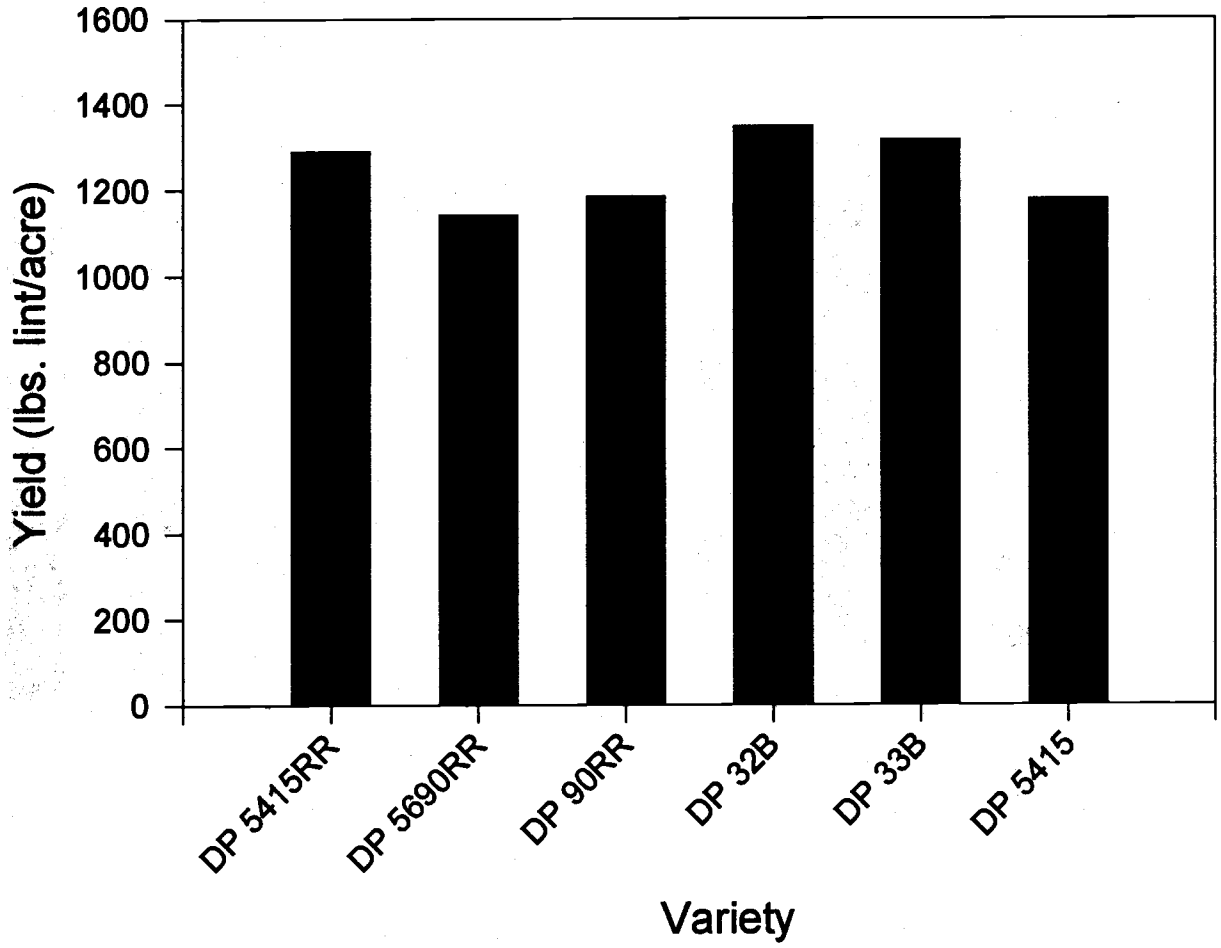

Figure 30. Yield comparisons for Bt vs. non-Bt varieties, Mohave Valley, AZ, 1997 (AVIKWA 'AME Farms).

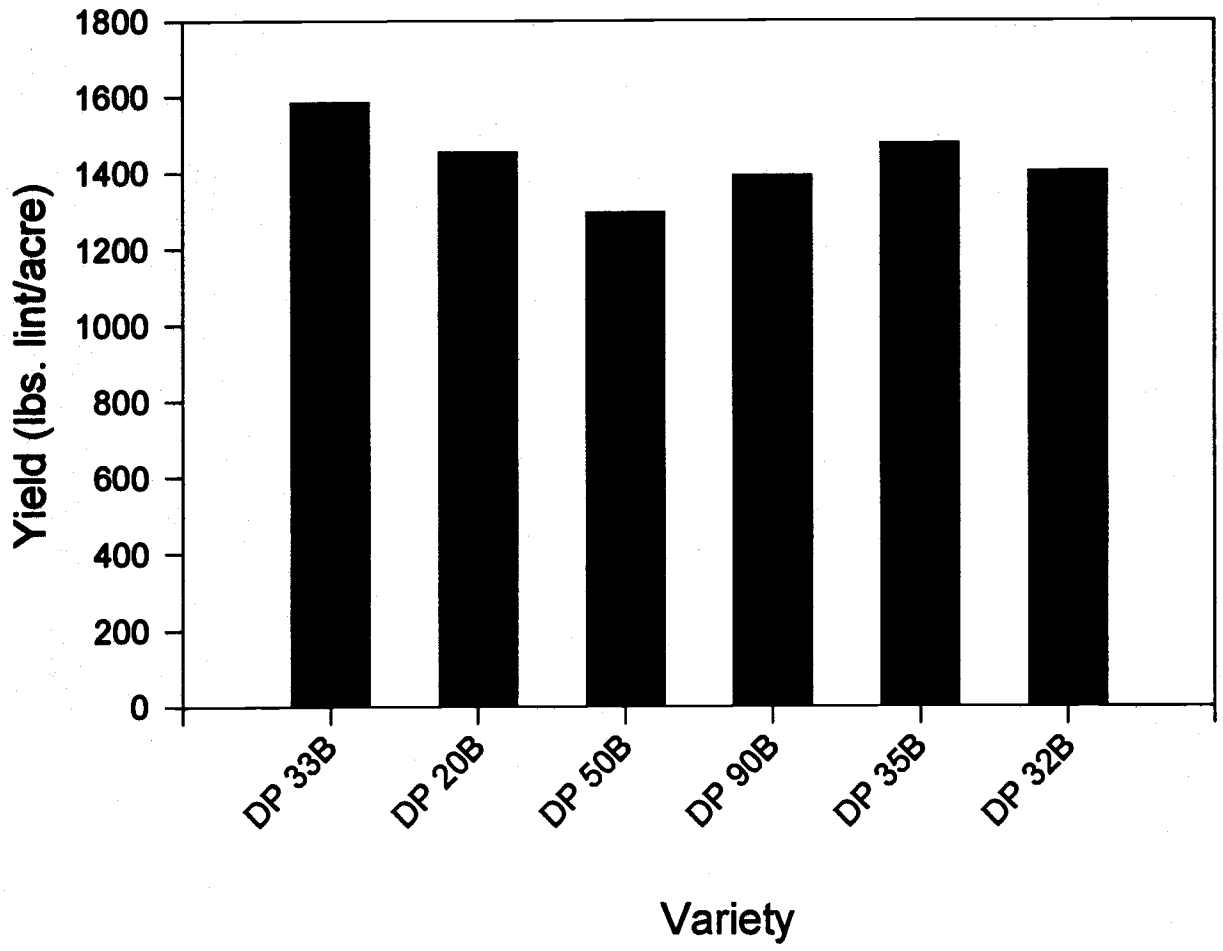

Figure 31. Yield comparisons for Bt vs. non-Bt varieties, Parker, AZ, 1997 (Bernal Brothers Farm).

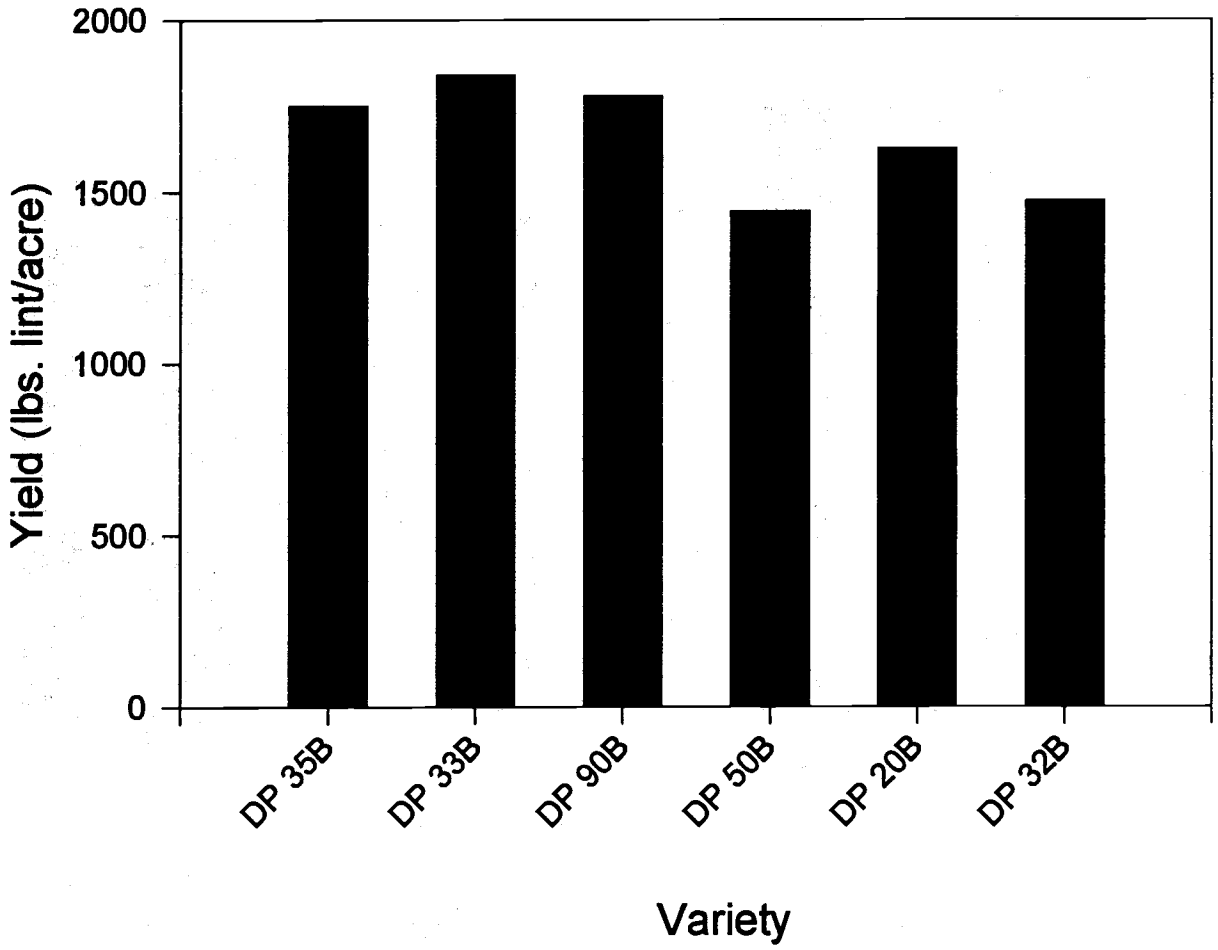

Figure 32. Yield comparisons for Bt vs. non-Bt varieties, Higley, AZ, 1997 (Power Enterprises).

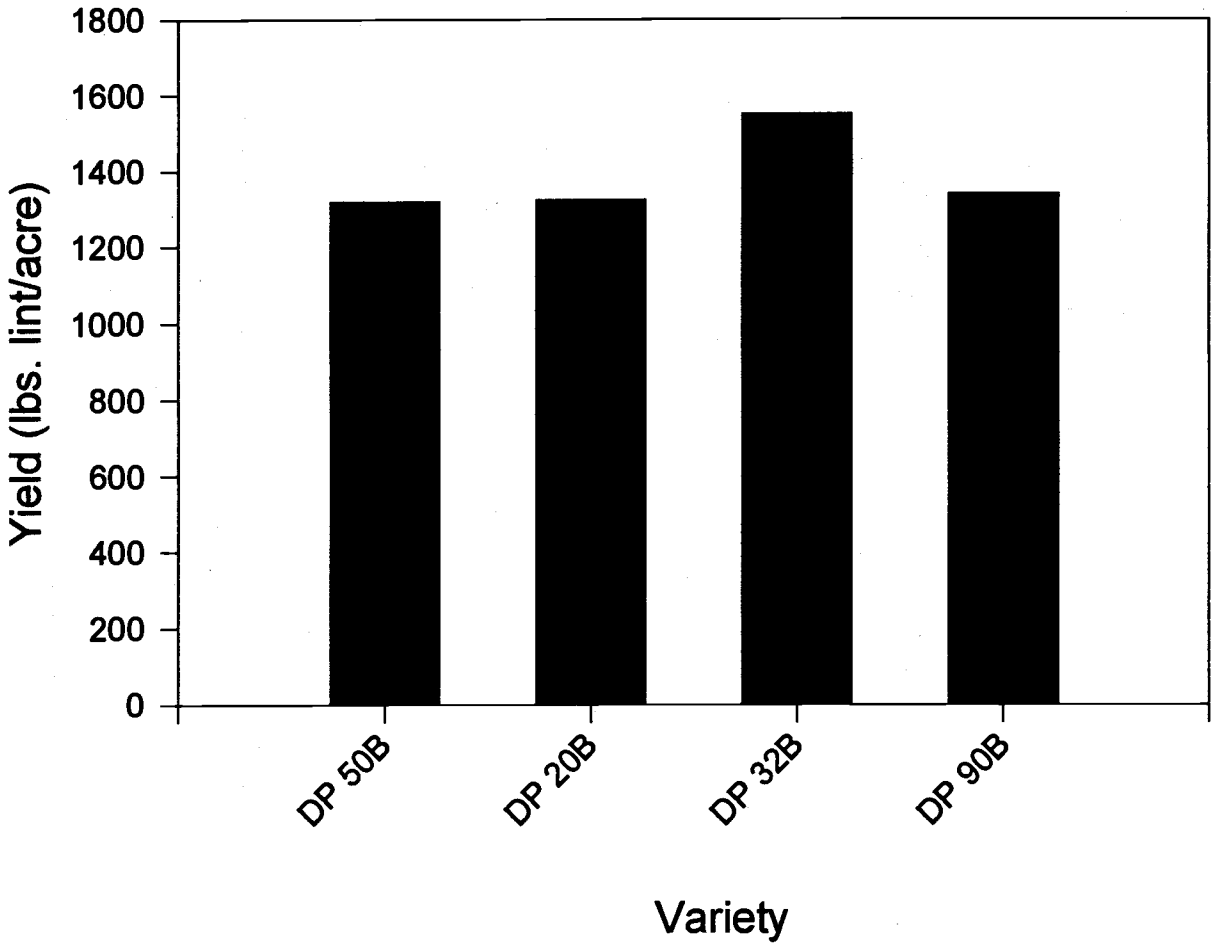

Figure 33. Yield comparisons for Bt vs. non-Bt varieties, Coolidge, AZ, 1997 (GLF Inc.).

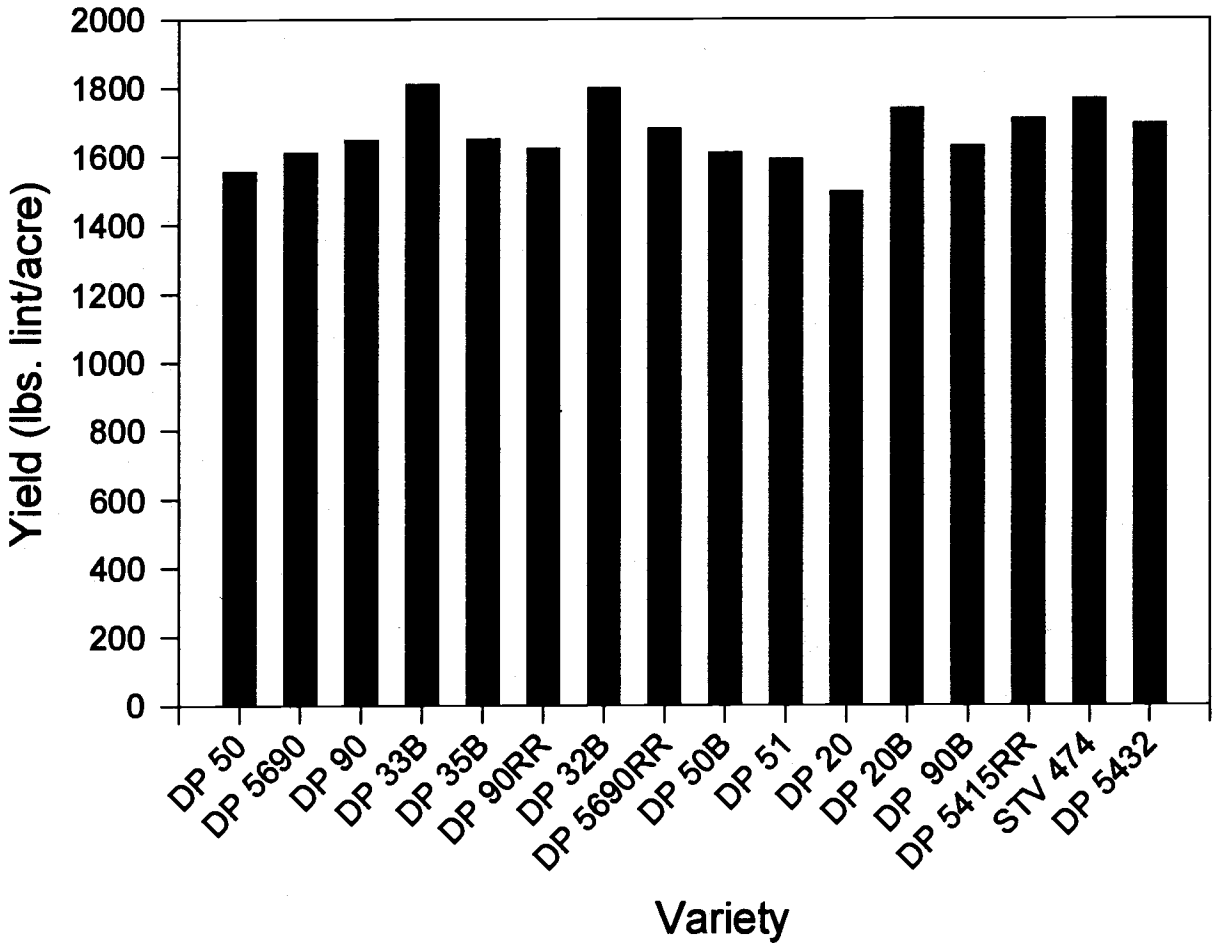

Figure 34. Yield comparisons for Bt vs. non-Bt varieties, Casa Grande, AZ, 1997 (Early Farming Co.).