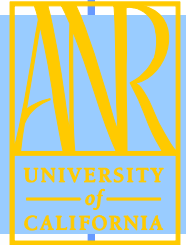


University of California Cooperative Extension

Blueberry Guide



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Blueberry Production in Coastal and Southern California

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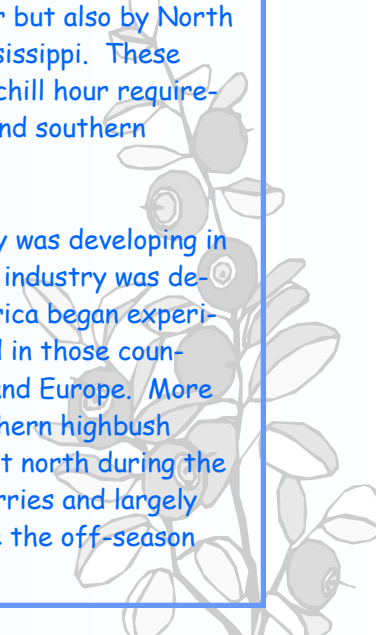


Overview of the US Blueberry Industry

Prior to the 1980s, commercial blueberry production in the US was largely confined to several eastern, southeastern, and northeastern states and Michigan. The US blueberry industry had evolved in the early 1900's through research programs at USDA and several eastern universities that took this native US crop plant and turned it into a commercially viable crop. There have traditionally been three species of blueberries with commercial importance: *Vaccinium corymbosum* hybrids (highbush), *Vaccinium angustifolium* or *V. myrtilloides* Michx (lowbush), and *V. ashei* Reade (rabbiteye) types. Of these the majority of production of blueberries has been of the highbush types because they showed the best productivity and the best combination of horticultural traits for the commercial market. And this production up until the 1980s was typically confined to the eastern and northern US and southern Canada and extending to Michigan. The production areas were largely defined by areas with cold enough winters to satisfy the highbush blueberry's chill requirement for flowering and fruiting and to break dormancy and for production areas with more acid soils. Blueberries evolved in areas of low soil pH and they traditionally have grown best where soils are below pH 5.2-5.3. Slowly during the 1980s and 1990s, production also spread to similar growing areas across Canada and to Washington and Oregon and also south into Florida and the southeast.

In the mid 1970's a cooperative plant breeding effort between the USDA and several universities in the southeastern US - including the University of Florida - led to the release of the first low-chill requirement "southern" highbush blueberry for early season production in the southeast. This southern highbush type originated from crossing the *V. corymbosum* (highbush) with a native evergreen Florida blueberry from *V. darrowi*. Prior to that time, growers in Florida and other parts of the southeast had harvested native rabbiteye-type blueberries for sale early in the year, before the arrival of the first highbush blueberries from more northern areas. This had traditionally been a period when blueberries were absent from the U.S. market and the early production brought very high prices. The release of Sharpblue and followed by other southern highbush types provided highbush-type varieties with fruit quality characteristics superior to those of the rabbiteyes. A number of low-chill, southern highbush varieties continued to be released by the U. of Florida in particular but also by North Carolina State University, the University of Arkansas, and the USDA in Mississippi. These varieties represented a wide range of adaptation especially with respect to chill hour requirements. Some of the lower chill varieties could even be produced in central and southern Florida with very few chilling hours.

During the same period that the "southern" highbush blueberry industry was developing in the southeastern US, a whole contra-cyclical fruit and vegetable production industry was developing in the southern hemisphere. Australia, New Zealand, and South Africa began experimenting with blueberries during the 1980s and 1990s and production evolved in those countries directed their domestic markets and exports to Asia, North America and Europe. More southern areas of Chile and Argentina also found that they could adapt northern highbush blueberries to similar latitudes in the southern hemisphere and ship the fruit north during the winter. As a result, Chile and later, Argentina planted large areas to blueberries and largely due to advantages related to relatively inexpensive labor, they now dominate the off-season



winter production period in the U.S. (Figs 4-6; Tables 5-6) and Europe. Argentina starts picking in mid October in a typical year and their peak production comes in December. Chile starts a little later in November and peaks in January. Chile, Argentina, and the southern hemisphere pretty much finish the harvest by mid March, but using controlled atmosphere storage, Chile continues shipping to North America and Europe into April and early May. Early domestic production from Florida continues to find extremely high prices when they begin in mid to late April as marketers are hungry for the first domestic berries (Figs 4-6).

Blueberries as a crop continued to expand in the US, Canada, and several southern hemisphere countries during the 1980s, 1990s, and early 2000s with growing worldwide demand and attempts by marketers to supply fruit year around to US and European markets. And production area and volume is continuing to expand in the US and around the world today (Tables 1-4).

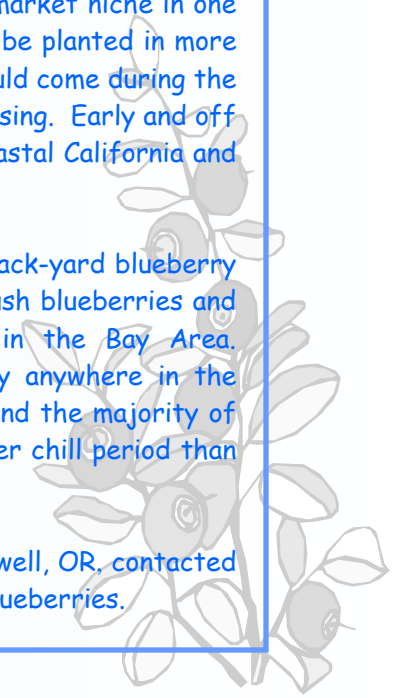
Recent reports confirm that per capita US consumption is continuing to increase (The Packer, July 30, 2007, pg C1). Current annual per capita consumption is 21.1 oz per person - 8.5 oz of this as fresh VS 16.8 oz and 5.5 oz as fresh per person annually in 2001. Now, many U.S. states produce blueberries, but the volume is still heavily concentrated during the months of June to August. There is still however, relatively little opportunity for additional production during the mid-fall or mid-spring periods when prices are highest, because of climate restrictions and the characteristics of blueberry flowering and fruiting. Mild coastal production areas of California are one of the rare situations where blueberries have been observed to produce during mid spring and fall periods. New trial blueberry plantings in Mexico may also eventually target mid-fall and mid-spring market windows.

Overview of the Developing California Blueberry Industry

Northern highbush blueberries are the most widely planted blueberries in the U.S. and worldwide but only the southern highbush varieties are important for early or off-season production in California. Rabbit-eye varieties may eventually find a special market niche in one or more parts of California and northern highbush varieties may eventually be planted in more northern parts of the state. But this production in more northern areas would come during the main season when prices are low and much would likely be diverted to processing. Early and off-season fresh market production is thus, largely limited to southern and coastal California and a few areas of southern Florida.

Prior to 1997, there were only small, rare, scattered commercial and back-yard blueberry plantings in California primarily based on older varieties of northern highbush blueberries and marketed directly through farm stands and to specialized groceries in the Bay Area. Blueberries had not traditionally been grown much in California or really anywhere in the southwestern US, because blueberries require acid soils to establish well and the majority of varieties available were northern highbush varieties requiring a longer winter chill period than typically available in much of California.

Beginning in the mid 1990s, Dave Brazelton of Fall Creek Nursery in Lowell, OR, contacted some California farmers and convinced them to establish trial plantings of blueberries.

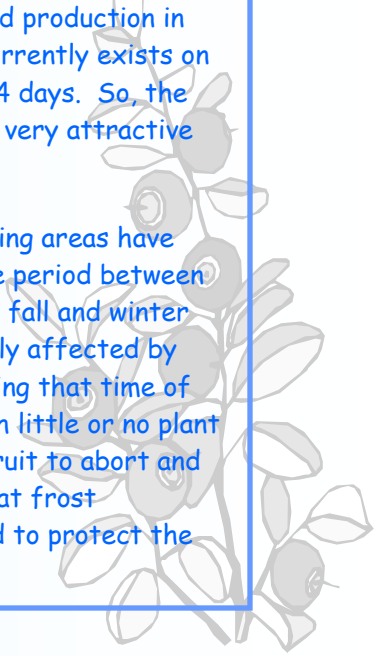


Brazelton also had a summary of key cultural practices that he provided to growers. In some cases the varieties thrived and showed that early season fruit production was a possibility. In other situations, the variety(s) chosen initially was poorly suited to the growing conditions and was removed and replaced with more promising varieties within 4 - 5 years. Also, in the late 1990's, UC farm advisors began establishing field trials with blueberries in the southern San Joaquin Valley and in San Luis Obispo, Santa Barbara, Ventura, and San Diego counties along the coast. These were the first comprehensive field trials evaluating a wide range of southern highbush varieties in California growing conditions.

Meanwhile, during the 1990s, University of Florida researchers began experimenting with the "evergreen" blueberry production system in Central and South Florida in which the plants do not enter dormancy and drop their leaves but remain green and actively growing year around. At more northern blueberry growing areas in Florida, the plants receive more chilling temperatures and typically lose their leaves in the fall and early winter and enter a light dormancy. In California, growing conditions along the central and south coast are generally milder and these conditions favor the evergreen growing system and the earlier production that accompanies it. Blueberry production in the interior valleys of California more closely mimics north Florida with at least some leaf drop and limited dormancy. Historically, 60% of Florida blueberry production has come after May 5 - primarily from the larger plantings in the northern part of the state. Likewise, 80% or more of SJV production comes after May 10.

Since the early 2000s, California blueberry acreage has grown consistently with new plantings in mild coastal areas and beginning in the southern San Joaquin Valley (SJV) near Arvin and more recently extending in the SJV to north of Sacramento. There have also been some planting in and around the San Francisco Bay area and in the Sierra foothills. In 2007 planted acreage in California is estimated to be approximately 4000 acres with perhaps 75% concentrated in the SJV. Of these 4000 acres, perhaps 20% would be full bearing mature plants, another 20%, new, nonbearing plants and the remaining 60% in various producing ages between 2 and 5 years. The blueberries grown in the central and southern SJV begin producing in late April at the earliest, significant production volume begins May 15-20 in a typical year. This period, mid-May to early June is likely to see substantial price pressure in the future as the new production volume in the SJV competes with established production in Florida and South Georgia. Even with high tunnel protected cropping which currently exists on approximately 200 acres in the SJV, they can only advance the harvest 10 - 14 days. So, the period prior to mid May and particularly after Chile finishes in mid March is a very attractive production period.

Growers and university trials in mild coastal and southern California growing areas have observed production from southern highbush blueberries in these areas in the period between February and May in a typical year. In some milder areas with some varieties, fall and winter blueberry production is even possible in open fields. The production is markedly affected by temperatures however, and a cold period will delay harvest days or weeks during that time of the year. Blueberry plants will tolerate temperatures well below freezing with little or no plant damage but temperatures only 3-5° F. below freezing will cause flowers and fruit to abort and the production is lost for that critical early season period. It is important that frost protection - typically from sprinkler irrigation or air mixing fans - be provided to protect the

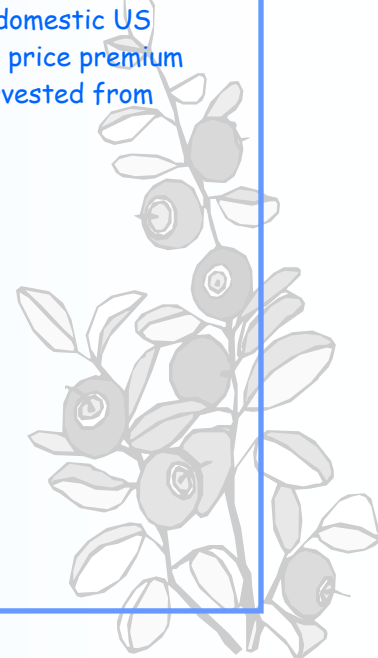


production. Some growers have added high tunnels to advance the harvest even further in these areas and to add an additional level of frost protection. And there will be years - such as 2007- when the temperature falls so low that no amount of frost protection will save the crop in all but the mildest growing areas. In spring of 2007, even generally frost free" coastal areas of San Diego County dropped into the low 20s F.

Historical Fresh Blueberry Wholesale Prices

Traditional blueberry wholesale prices track closely that of supplies from domestic and off-shore sources (Figs 1-3). The weekly wholesale prices for fresh blueberries in the Los Angeles Terminal Market for the most recent years (2004-2006) are typical of annual price fluctuations with prices peaking in mid-late April and with lowest prices during the mid summer. Midsummer low prices correspond to a period when blueberries are available from multiple domestic growing areas on the East Coast, as well as Michigan, Oregon, Washington and more recently, California. Washington, Oregon, and Canada store some of their late summer harvest in CA and continue shipping from storage stocks during the September to November period.

The off season from October to May had - prior to 1995 - traditionally been a period of relatively high prices but in recent years, Chile and Argentina have filled much of that period with their contra cyclical production (Figs 4-5; Tables 5,6). Typically Argentina starts in October and picks into January and Chile starts in November or December and goes into mid March. New Zealand, Australia, and most recently Mexico have also shipped intermittently during winter periods. There are large areas of additional new plantings in Argentina and Chile that will continue to increase the supply to the off-season market from the southern hemisphere in coming years. Chilean and Argentinean exporters are already complaining of rising fuel costs and constant fuel surcharges and their long boat trip and expensive air freight will likely limit further expansion as US and Mexican production increases some for the off-season market. Likewise, Chile and Argentina are seeing some of their blueberry hold on European markets begin to be challenged by new plantings in Spain, Portugal, and Morocco. It is also interesting to note that when blueberries are in the US market from domestic US sources (California or Florida) in late spring, they typically maintain a marked price premium over the offshore fruit. Fruit buyers will often prefer the fresher fruit harvested from closer production areas if given a choice.



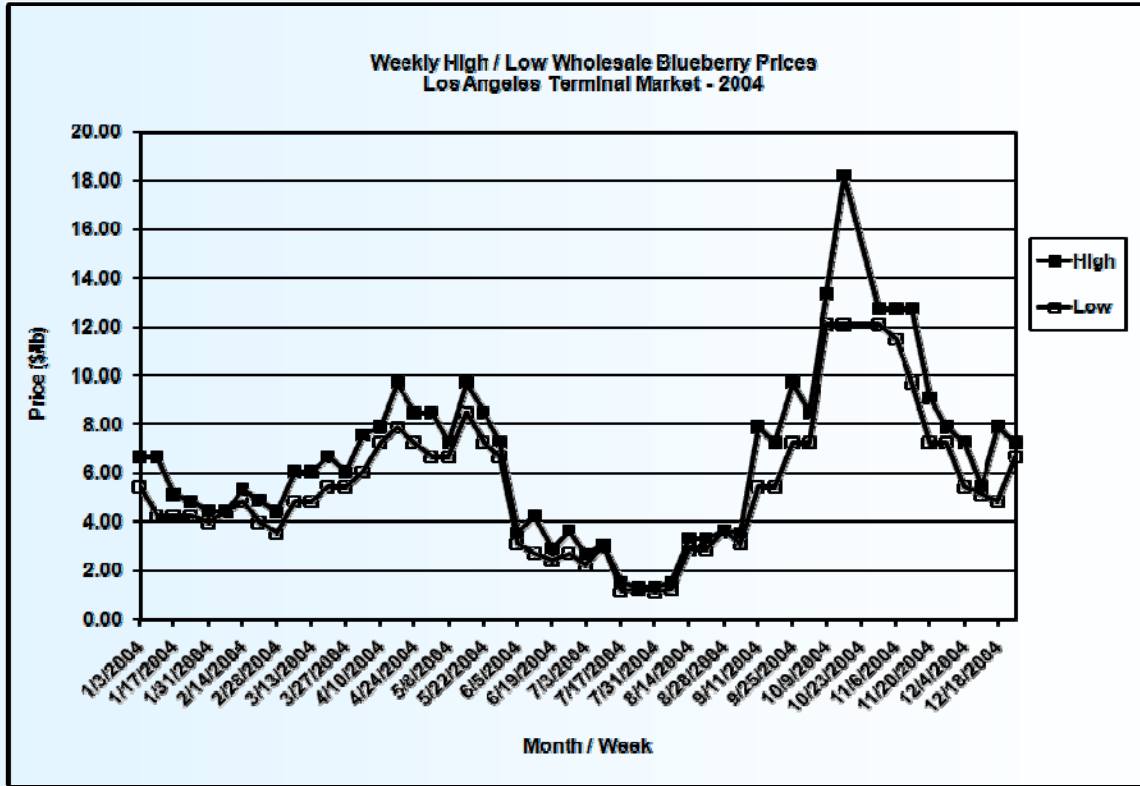


Figure 1. Weekly high/low wholesale blueberry prices for 2004. Los Angeles Wholesale Terminal Market. Source: USDA Agricultural Marketing Service.

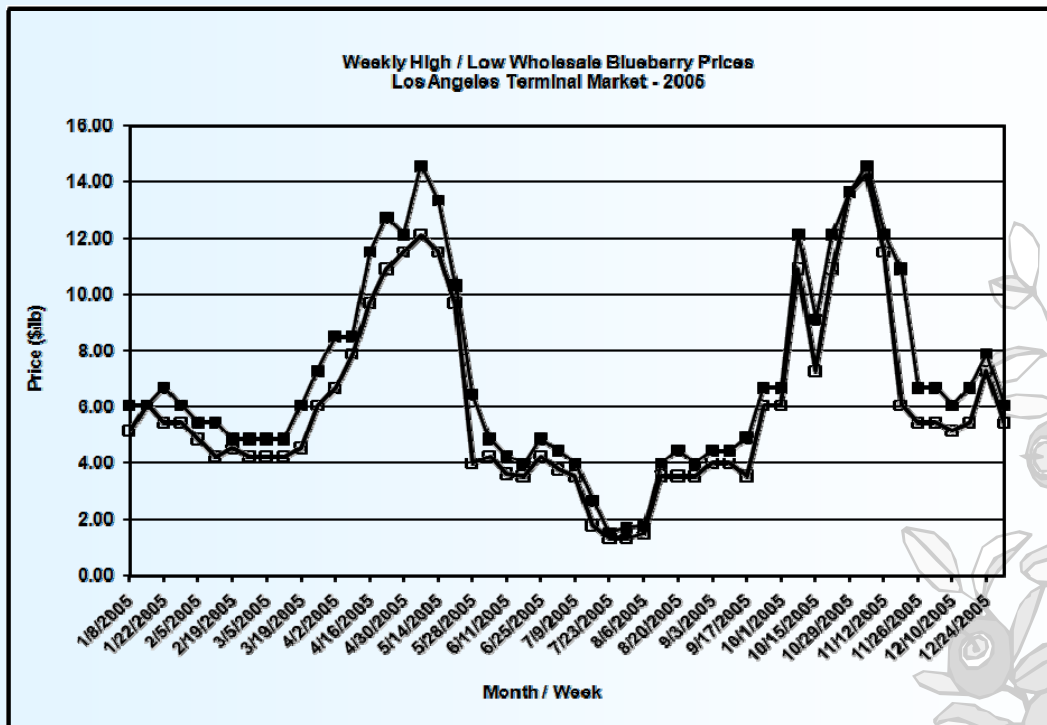


Figure 2. Weekly high/low wholesale blueberry prices for 2005. Los Angeles Wholesale Terminal Market. Source: USDA Agricultural Marketing Service.

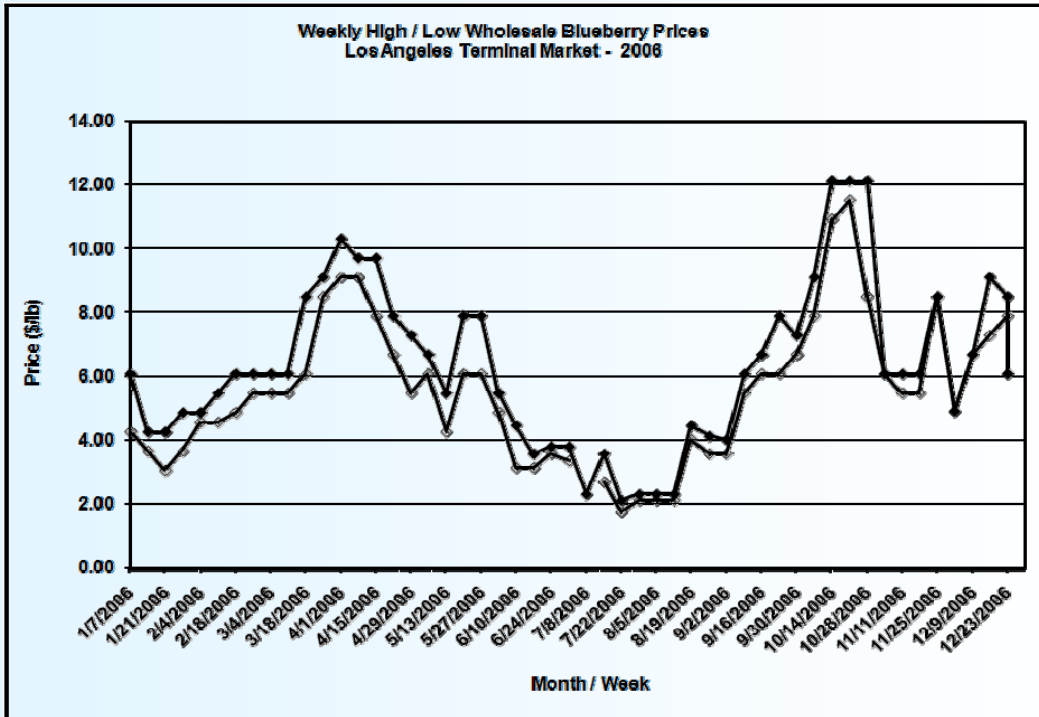


Figure 3. Weekly high/low wholesale blueberry prices for 2006. Los Angeles Wholesale Terminal Market. Source: USDA Agricultural Marketing Service.

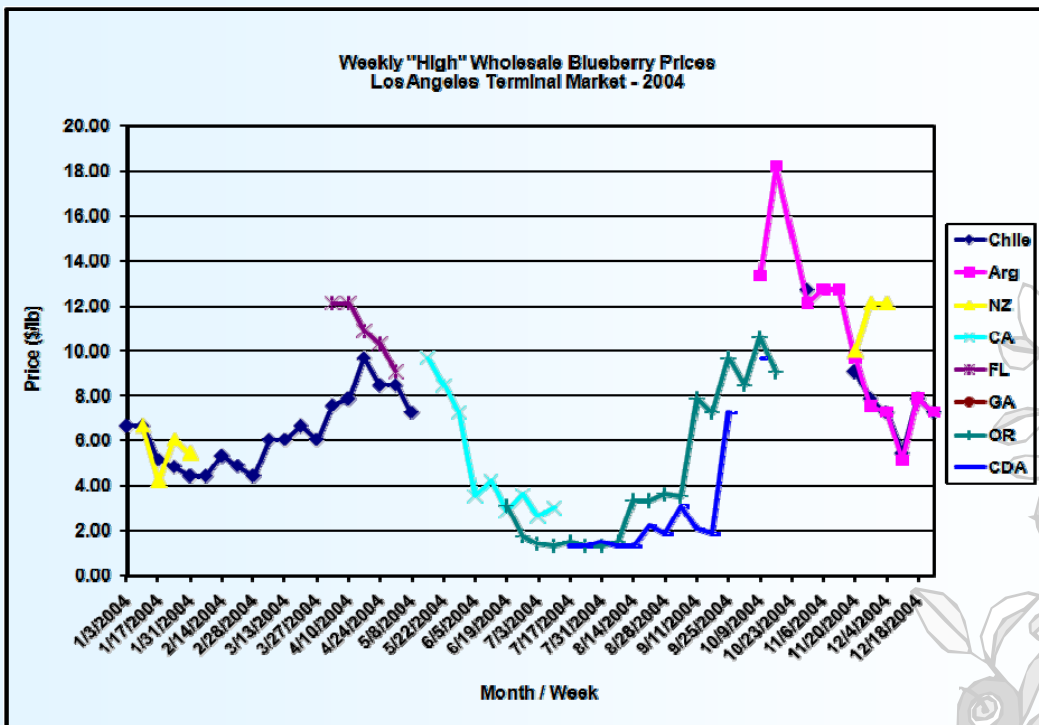


Figure 4. Weekly wholesale blueberry prices by U.S. domestic or foreign shipping point for 2004. Los Angeles Wholesale Terminal Market. Source: USDA Agricultural Marketing Service.

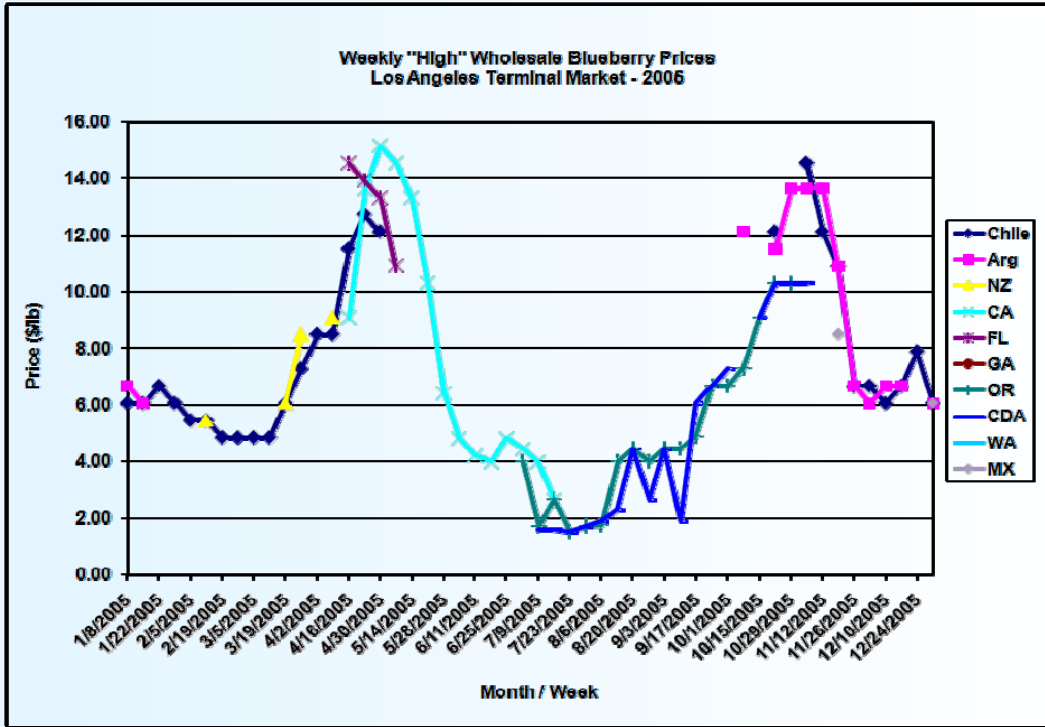


Figure 5. Weekly wholesale blueberry prices by U.S. domestic or foreign shipping point for 2005. Los Angeles Wholesale Terminal Market. Source: USDA Agricultural

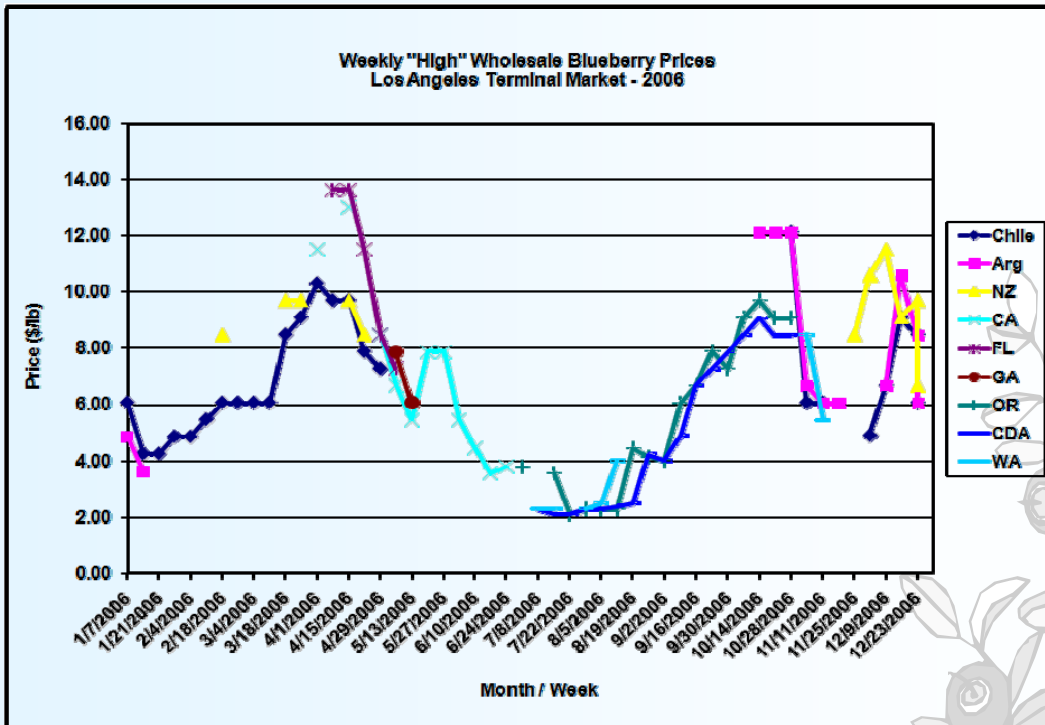


Figure 6. Weekly wholesale blueberry prices by U.S. domestic or foreign shipping point for 2006. Los Angeles Wholesale Terminal Market. Source: USDA Agricultural Marketing Service.

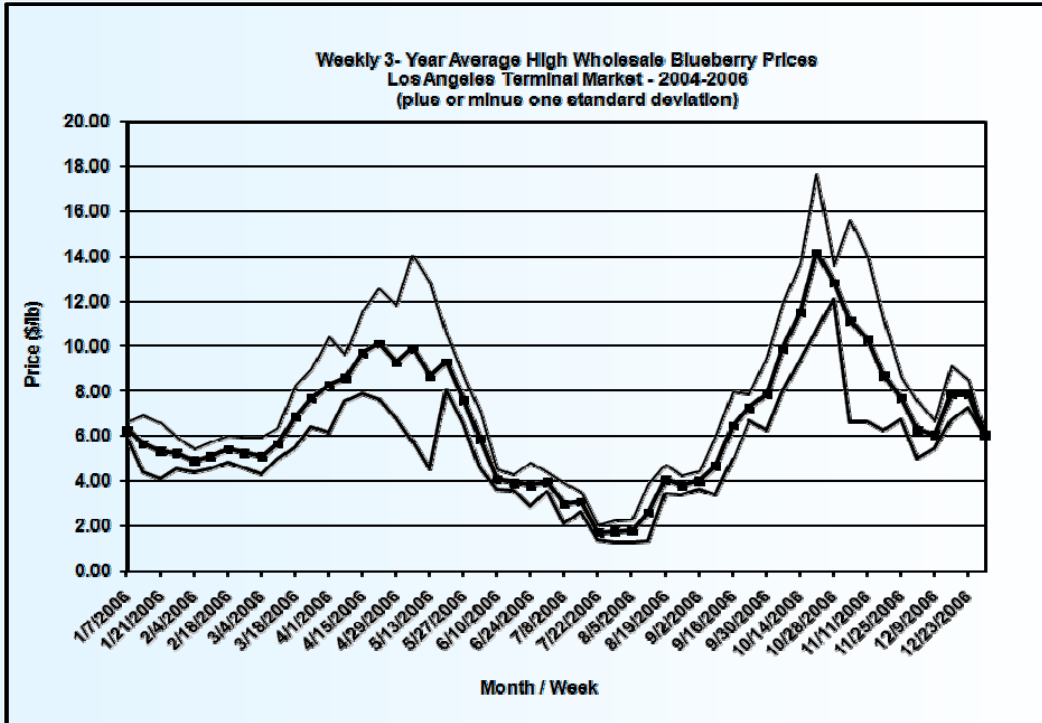


Figure 7. Three year average weekly wholesale blueberry prices 2004 - 2006. Los Angeles Wholesale Terminal Market. Source: USDA Agricultural Marketing Service.

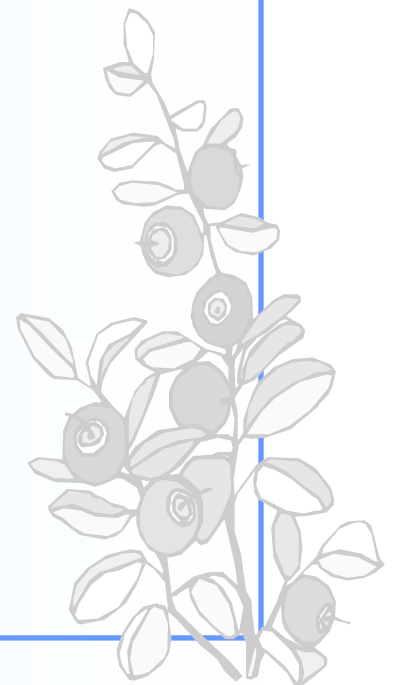


Table 1. Blueberry harvested acreage, yield, production and utilization by State and U.S. 2004-2006.

State & Year Proc-essed	Area Harvested	Per Acre 1/	YIELD	PRODUCTION		UTILIZATION
			Total	Utilized	Fresh	Processed
Cultivated Blueberries		Acres	Pounds	-----	1,000 pounds	-----
AL 2/						
2004		300	1,900	980	570	570
2005		280	1,860	750	520	520
2006		270	1,190	440	320	320
AR 2/						
2004		530	3,400	1,900	1,800	1,800
2005		530	2,550	1,500	1,350	1,350
2006		530	3,020	1,650	1,600	1,600
CA 3/						
2004						
2005 2/		2,000	4,550	9,100	9,100	9,100
2006 2/		2,300	4,350	10,000	10,000	10,000
FL 2/						
2004		2,300	2,430	6,000	5,600	5,600
2005		2,500	2,080	5,200	5,200	5,200
2006		2,600	2,690	7,040	7,000	7,000
GA						
2004	4,800	4,380	21,000	21,000	10,000	11,000
2005	6,000	4,330	26,000	26,000	12,000	14,000
2006	7,000	4,500	31,500	31,500	16,000	15,500
IN						
2004	600	5,000	3,100	3,000	1,500	1,500
2005	600	5,830	3,500	3,500	2,000	1,500
2006	620	5,480	3,400	3,400	1,900	1,500
MI						
2004	17,400	4,600	80,000	80,000	36,000	44,000
2005	16,800	3,930	66,000	66,000	25,000	41,000
2006	16,700	4,970	83,000	83,000	29,000	54,000
MS 4/						
2004						
2005						
2006	2,000	2,300	4,600	4,600	2,600	2,000
NJ						
2004	7,500	5,200	39,000	39,000	33,000	6,000
2005	7,500	6,000	45,000	45,000	33,000	12,000
2006	7,600	6,840	52,000	52,000	40,000	12,000

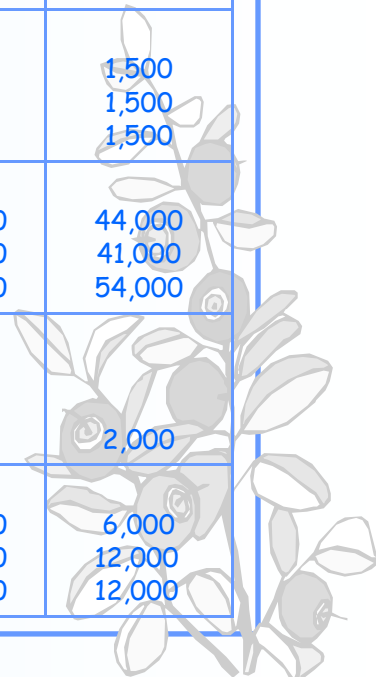


Table 1 (continued). Blueberry harvested acreage, yield, production and utilization by State and U.S. 2004-2006.

State & Year Proc-essed	Area Harvested	Per Acre 1/	YIELD	PRODUCTION		UTILIZATION
			Total	Utilized	Fresh	Processed
(continued) Cultivated Blueberries		Acres	Pounds	-----	1,000 pounds	-----
NY						
2004	700	2,430	2,000	1,700	1,400	300
2005	700	2,000	1,500	1,400	1,350	50
2006	700	2,860	2,200	2,000	1,950	50
NC						
2004	4,400	5,200	22,900	22,900	16,400	6,500
2005	5,000	5,200	26,000	26,000	16,100	9,900
2006	4,700	5,430	25,500	25,500	17,900	7,600
OR						
2004	3,500	9,710	34,000	34,000	13,400	20,600
2005	4,000	8,630	34,500	34,500	13,800	20,700
2006	4,400	8,090	35,600	35,600	13,900	21,700
WA						
2004	2,400	7,500	18,000	18,000	5,000	13,000
2005	2,800	7,000	19,600	19,600	3,900	15,700
2006	3,400	5,590	19,000	19,000	4,500	14,500
US						
2004	44,430	5,120	228,880	227,570	124,550	103,020
2005	48,710	4,890	238,650	238,170	123,100	115,070
2006	52,820	5,220	275,930	275,520	146,130	129,390
Wild Blueberries						
ME						
2004			46,000	46,000	300	45,700
2005			60,150	60,150	350	59,800
2006			74,600	74,600	400	74,200

1/ Yield is based on utilized production

2/ Small quantities of processed blueberries are included in fresh to avoid disclosure of Individual operations.

3/ Estimates began in 2005

4/ Estimates began in 2006

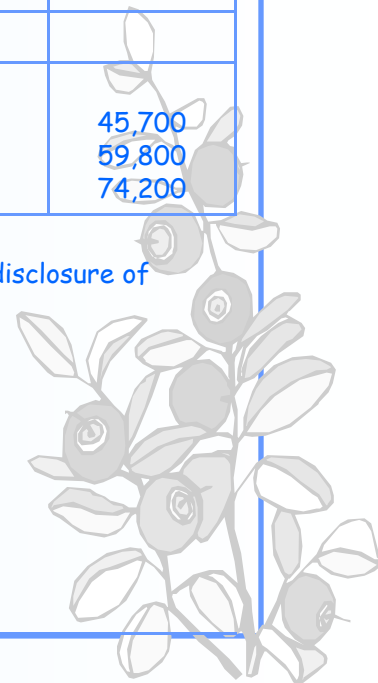


Table 2. Prices and values by state and US

Crop, State & Year	Price per Pound			Value of Production		
	FRESH	PROCESSED	ALL	FRESH	PROCESSED	ALL
Cultivated Blueberries	----- Dollars -----			----- 1,000 Dollars -----		
AL 1/						
2004	1.230		1.230	699		699
2005	0.906		0.906	471		471
2006	1.380		1.380	442		442
AR 1/						
2004	1.230		1.230	2.216		2.216
2005	1.740		1.740	2.349		2.349
2006	1.550		1.550	2.486		2.486
CA 2/						
2004						
2005 1/	4.460		4.460	40,583		40,583
2006 1/	3.280		3.280	32,800		32,800
FL 1/						
2004	4.500		4.500	25,200		25,200
2005	6.300		6.300	32,760		32,760
2006	4.700		4.700	32,900		32,900
GA						
2004	1.640	0.670	1.130	16,400	7,370	23,770
2005	1.730	0.790	1.220	20,760	11,060	31,820
2006	2.370	1.410	1.900	37,920	21,855	59,775
IN						
2004	1.330	0.850	1.090	1,995	1,275	3,270
2005	1.410	0.970	1.220	2,820	1,455	4,275
2006	1.600	1.320	1.480	3,040	1,980	5,020
MI						
2004	1.600	0.900	1.220	57,600	39,610	97,210
2005	1.700	1.000	1.270	42,500	41,000	83,500
2006	2.150	1.430	1.680	62,350	77,397	139,747
MS 3/						
2004						
2005						
2006	1.400	1.200	1.310	3,640	2,400	6,040
NJ						
2004	1.210	0.950	1.170	39,930	5,700	45,630
2005	1.310	1.020	1.230	43,230	12,240	55,470
2006	1.640	1.510	1.610	65,500	18,120	83,720

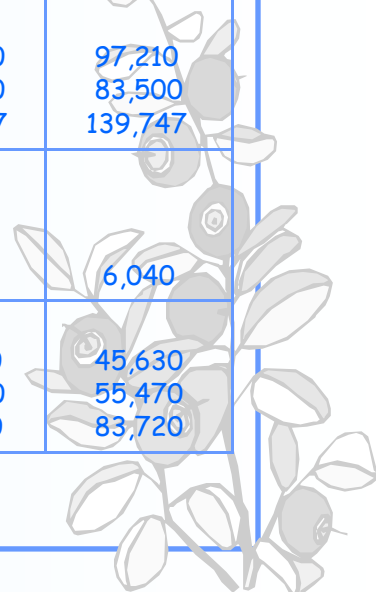


Table 2 (continued). Prices and values by state and US

Crop, State & Year Total	Price per Pound			Value of Production		
	FRESH	PROCESSED	ALL	FRESH	PROCESSED	ALL
Cultivated Blueberries (continued)	----- Dollars -----			----- 1,000 Dollars -----		
NY						
2004	1.450	0.950	1.360	2,030	285	2,315
2005	1.420	0.920	1.400	1,917	46	1,963
2006	1.410	0.920	1.400	2,750	46	2,796
NC						
2004	1.700	0.670	1.410	27,880	4,355	32,235
2005	1.800	0.780	1.410	28,980	7,722	36,702
2006	2.150	1.350	1.910	38,485	10,260	48,745
OR						
2004	0.970	0.700	0.806	12,998	14,420	27,418
2005	1.210	0.800	0.964	16,698	16,560	33,258
2006	1.790	1.300	1.490	24,881	28,210	53,091
WA						
2004	1.250	0.750	0.889	6,250	9,750	16,000
2005	1.330	0.890	0.978	5,187	13,973	19,160
2006	2.380	1.340	1.590	10,710	19,430	30,140
US						
2004	1.550	0.805	1.210	193,058	82,905	275,963
2005	1.930	0.910	1.440	237,595	104,716	342,311
2006	2.170	1.400	1.810	316,690	181,012	497,702
Wild Blueberries						
ME						
2004	1.350	0.450	0.456	405	20,565	20,970
2005	1.600	0.650	0.656	560	38,870	39,430
2006	1.700	0.800	0.805	680	59,360	60,040

1/ Small quantities of processed blueberries are included in fresh to avoid disclosure of individual operations.

2/ Estimates began in 2005

3/ Estimates began in 2006

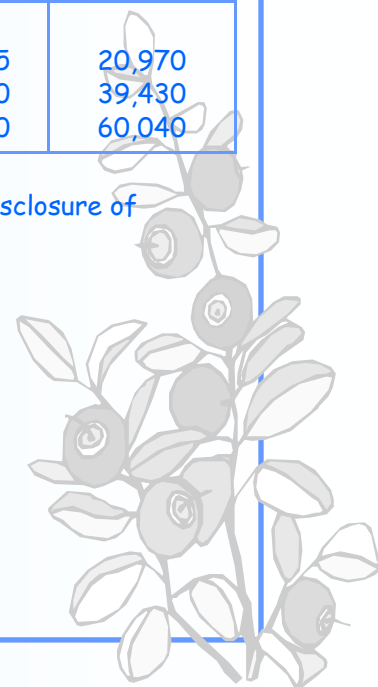


Table 3. Value of U.S. blueberry crop. 2004-2006

Year	Price per Pound			Value of Production		
	FRESH	PROCESSED	ALL	FRESH	PROCESSED	ALL
	----- Dollars -----			----- 1,000 Dollars -----		
2004	1.550	0.805	1.210	193,058	82,905	275,963
2005	1.930	0.910	1.440	237,595	104,716	342,311
2006	2.170	1.400	1.810	316,690	181,012	497,702

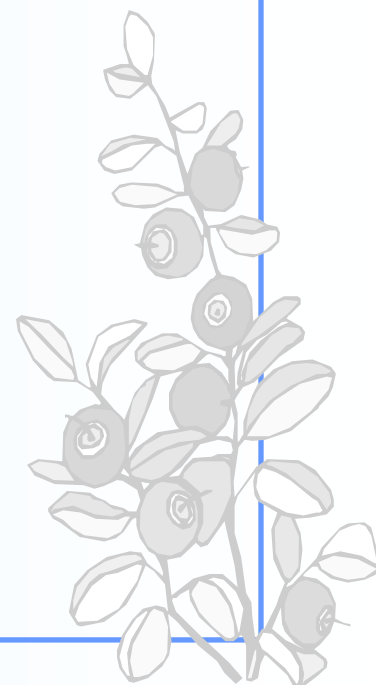
Source: USDA/NASS, Mann Lab, Cornell University

Table 4. Acreage and volume of U.S. blueberry crop. 2004-2006

Year	Harvested	YIELD		PRODUCTION		UTILIZATION
		Per Acre 1/	Total	Utilized	Fresh	Processed
		Acres	Pounds	----- 1,000 pounds -----		
2004	44,430	5,120	228,880	227,570	124,550	103,020
2005	48,710	4,890	238,650	238,170	123,100	115,070
2006	52,820	5,220	275,930	275,520	146,130	129,390

1/ Yield is based on utilized production

Source: National Ag. Statistics Service, Mann Lab, Cornell University



The Southern Highbush Blueberry Plant

Blueberries are deciduous woody perennial crop plants that will live for 30 years or more. In colder climates, plants will lose their leaves and enter a winter dormant period. In mild winter climates, many low chill southern highbush- and rabbiteye-type blueberries will retain their leaves in an evergreen production system. The southern highbush blueberries are erect or open-spreading plants to 2 m (6 ft) high. The root system is fibrous and very superficial with no dominant tap root.

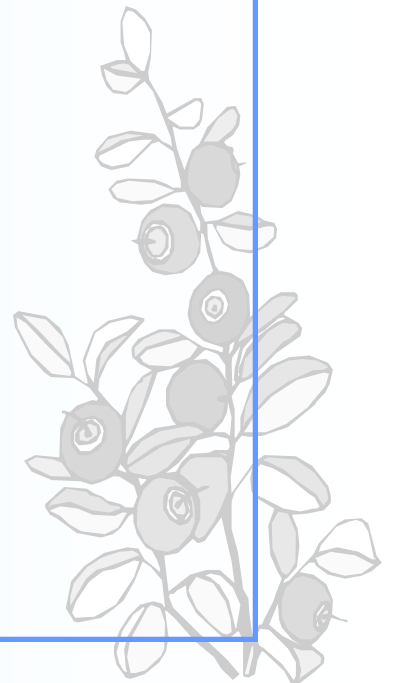


Fig. 1. Blueberry crown showing emerging canes and superficial fibrous root system.

Blueberries as a group are acid-loving, sensitive to soil pH, and inefficient at iron uptake. If grown in a soil environment where pH rises above 5.2-5.5, the plants will be pale and lack vigor due to pH-induced iron deficiency chlorosis. Blueberries are also intolerant of poor soil drainage and moisture stress. While established, older plants may tolerate moisture stress to some extent, moisture stress for even short periods will reduce plant vigor, fruit yield, and fruit quality.



Fig. 2. Leaf yellowing on new growth typical for pH-induced iron deficiency chlorosis.



Blueberry plants develop from a series of canes that emerge from the crown at the base of the plant from above ground or below ground branches. Management in the early years of a new planting is directed toward encouraging the development of a succession of new canes -

each taller and thicker than the previous cane. Selective, periodic pruning will encourage new cane development from more basal branches where larger, thicker canes emerge.

The plant freely branches from existing canes with smaller branches concentrated on the upper parts of emerged canes or renewed canes from the crown or below ground.



Fig. 3. Principal canes of blueberry plant emerge from the crown at the base of the plant.

Flowering and Fruit Development

Plants flower and fruit on older wood - from 4-6-month-old canes in mild growing areas with long seasons or - from the previous season's growth in colder areas. Developing buds on branches from older canes switch from a vegetative bud to a flower bud. Vegetative buds are small, narrow and flattened, while flower buds are round and more prominent. Plants flower first on the end of a flower cluster and develop downward. Flower clusters are typically 5-10 flowers per bud.



Fig. 4-5. Developing buds on older branches switch from a vegetative bud to a flower bud.

Normally, 65-75 days pass from pollination to harvest, but the timing varies with variety and is temperature-related and can extend days or weeks. Flowering and fruiting continues for 1-3 months depending upon variety and climate conditions.

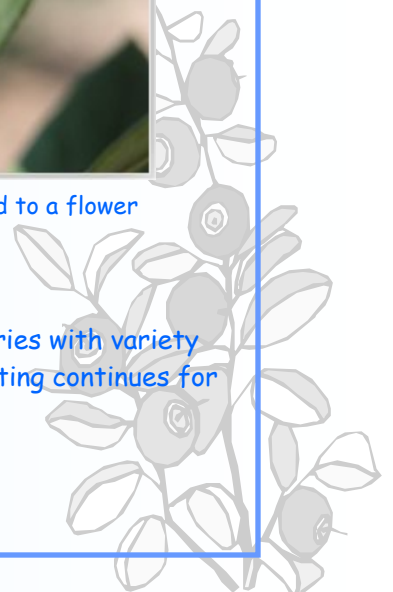




Fig. 7. Swollen flower buds transitioning to developing flowers.



Fig. 8. Blueberry flower buds transitioning up the stem to open flowers.



Fig. 6. Bees are essential for pollination of the large number of flowers needed for optimum production.

Management practices in the first 1-5 years are directed toward establishing a large plant structure on which to set fruit. The ideal shape is an open, cup-shaped interior that improves light and air distribution. And fertilization, pruning and other cultural practices are directed at developing that form.



Blueberry Variety Selection

Cultivar (variety) selection is perhaps the most important aspect of starting a new commercial blueberry planting. There are numerous productive varieties available and more continually be released from public and private breeding programs. Blueberries have several different important characteristics such as yield, fruit size, color, firmness, flavor, scar strength, disease resistance, post harvest shelf-life, etc. that contribute to adaptation in a specific area. There is a tendency to assume that newer varieties are always better but in fact it is necessary to evaluate varieties old and new in specific growing conditions to determine those best adapted. There are many fine older varieties that often may fit specific production constraints well. And newer varieties may show weaknesses or shortcomings once they are propagated and grown on a large scale over an extended period. So growers continually evaluate new varieties as they come available and change varieties when needed, replacing reliable, productive older varieties slowly only after a staged trial process.

In California southern and coastal growing areas, it is possible to harvest blueberries early in the year (February - May) when prices are often more attractive. Producing during this early period means combining very mild (frost free or nearly frost free) growing conditions with early producing low chill varieties. These varieties will begin flowering with little or no chill; some will actually produce fruit in autumn and early winter after flowering without prechilling.

Variety Patents and Licensing. Most new blueberry varieties are patented by the breeder or the breeder's representative as a means of controlling propagation and distribution to assure recovery of some of the costs of maintaining a variety development program. These costs are recovered through a royalty on the plants established by the licensed nursery and paid by the grower. In some instances, in lieu of licensing of a nursery or nurseries to control propagation and distribution, the licensee may instead be a fruit marketing company that arranges royalty payments based on the amount of fruit sold in commercial channels. Growers should check on variety availability early in planning new blueberry plantings to assure that there are no restrictions on the availability of plant material of the desired variety(s).

Blueberry Plant Types The two types of blueberries that will produce reliably in mild climate growing areas are southern highbush (SHB) and rabbiteye types. The southern highbush types are generally preferable because they are earlier and have better horticultural fruit quality characteristics. Rabbiteye varieties are vigorous, tolerate higher soil pH and other stresses, and typically produce later in the season. So, while the emphasis for off-season production is clearly on southern highbush types, there eventually may be a role for selected rabbiteye varieties in certain situations depending on the target market.

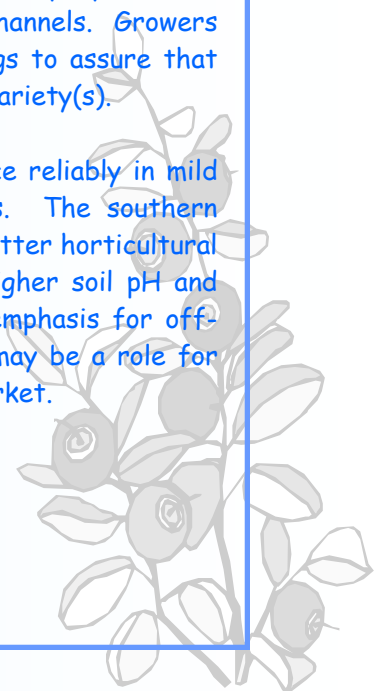




Figure xx Southern highbush blueberry plant.



Figure xx Rabbiteye blueberry plant

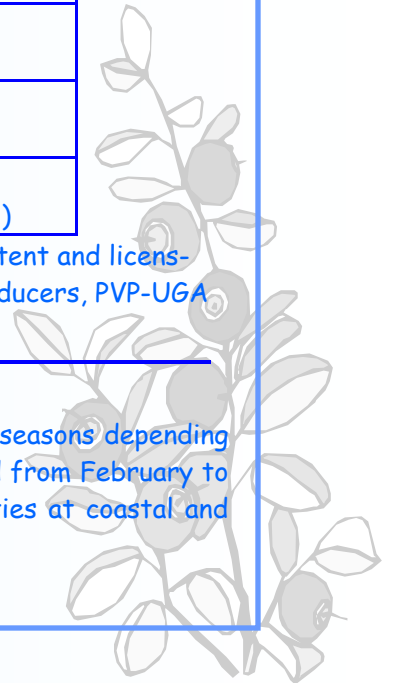
There are many commercial SHB blueberry varieties available through nurseries. In many countries or geographical areas, newer varieties may be protected by plant patents and their propagation and distribution limited by licensing agreements.

The lower chill requirement, early producing SHB varieties are recommended for mild winter climates. Varieties shown to be promising in diverse mild climate growing areas include the following:

Sharpblue	Star (PVP-UFL) ^{1/}	Abundance (PVP -UFL)	Spring Wide (PVP-UFL)
Biloxi	Gulf Coast	Southmoon (PVP -UFL)	Spring High (PVP)
Misty	Ozarkblue	Snow Chaser (PVP-UFL)	Palmetto (PVP-UGA)
Blue Crisp (PVP-UFL)	Jewel (PVP-UFL)	Sweet Crisp (PVP-UFL)	Rebel (PVP-UGA)
Sapphire (PVP-UFL)	Emerald (PVP-UFL)	Primadona (PVP-UFL)	Camellia (PVP -UGA)

^{1/}PVP - Plant variety protection indicates a patented variety. UFL indicates patent and licensing rights controlled by the University of Florida, Florida Foundation Seed Producers, PVP-UGA indicates patent and license rights controlled by the University of Georgia.

The harvest period varies with the growing area and across growing seasons depending upon chill hour accumulation and the heat unit accumulation during the period from February to May. The following graph illustrate the harvest period for selected varieties at coastal and southern California growing areas.



Typical harvest periods at coastal and southern California sites^{1/}

Variety	February	March	April	May	June	July	August
Star		XXXXXXXXXXXXXXXXXXXXXXXXXXXX					
Sharpblue		XXXXXXXXXXXXXXXXXXXXXXXXXXXX					
Jewel		XXXXXXXXXXXXXXXXXXXXXXXXXXXX					
Emerald		XXXXXXXXXXXXXXXXXXXXXXXXXXXX					
Sapphire	XXXXXXXXXXXXXXXXXXXXXXXXXXXX						XXXXX
Misty		XXXXXXXXXXXXXXXXXXXX					
Gulf Coast			XXXXXXXXXXXX				
Biloxi			XXXXXXXXXXXX				
Southmoon			XXXXXXXXXXXX				
Blue Crisp				XXXXXXXXXXXX			
Legacy				XXXXXXXXXXXX			
Ozarkblue				XXXXXXXXXXXX			

^{1/}assuming frost free or frost protection

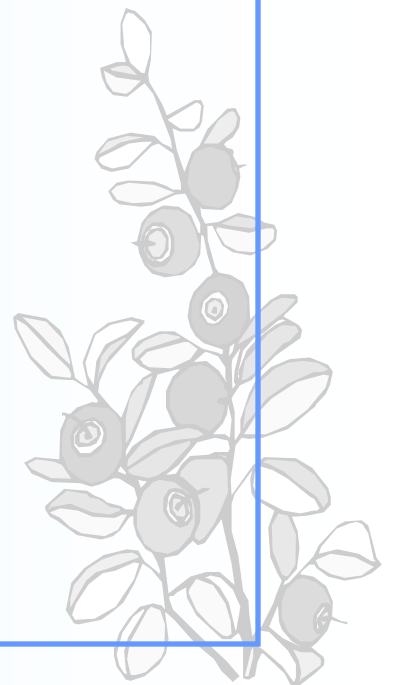
Note: the recently released SHB varieties Abundance, Primadona, Sweet Crisp, Snowchaser, Spring High, Spring Wide, Rebel, Camellia, and Palmetto also appear to have sufficiently low chill requirement to be well adapted to coastal and southern California but information is not yet available on the harvest periods for these varieties.

The productivity of these varieties varies markedly with the area where they are grown, the soil type, and the time of year they produce. A mix of appropriate varieties will enable growers to combine desirable horticultural characteristics such as plant vigor, plant yield and quality with production during periods of desired market window(s). It is important that the different varieties be evaluated in each selected potential production area. The production and production period is largely determined by an interaction among 1) the chill-hours available in the area, 2) the variety, 3) the heat unit accumulation during flowering and fruit ripening, and other cultural practices such as pruning and soil and water management.. Even among varieties having similar chilling requirement there are variations in ripening time and harvest date due to differences in heat unit requirements for flowering and fruit development. These factors interact with each other and can markedly affect production and they illustrate why varieties can vary dramatically even in what appear to be similar growing environments.

The SHB varieties have less winter hardiness as a group than the NHB varieties but that is not an issue in the mild winter areas and the SHB varieties continue growing late into the fall or winter or in mildest areas remain green year around. The earliest producing varieties tend to have the lowest chill requirement. These earliest varieties also are most susceptible to frost and in areas where there is threat of frost or the plants are not in protected tunnels, frost protection will be needed to prevent blossom or fruit damage. So, the earliest market window with the most attractive prices carries the additional greater frost risk and the additional frost protection investment.



Additional considerations Many growers are replacing Sharpblue and Misty with newer low chill varieties such as Emerald and Jewel, because Sharpblue tends to produce smaller fruit and has a reputation also for a leaky scar end. The Gulf Coast variety also has been replaced on many farms because while it is early, vigorous, and productive, a high percentage of the fruit retain their stems when picked and this requires additional labor to remove these stem pieces prior to shipping. The plant shape may also be an important consideration. More upright varieties such as Star require less pruning and this can reduce costs. Larger fruited varieties such as Emerald and Jewel may also reduce harvest costs and in some markets the larger fruit may be more desirable. But the larger size of fruit may also affect fruit firmness or flavor. Some varieties are more flexible with regard to harvest period - Sapphire, Emerald, and Sharpblue, tend to flower multiple times during the year in mild climate zones and this may enable production during additional fall harvest windows.



Site Selection

Early season blueberry production requires a mild winter climate combined with low-chill varieties and frost protection. Many of the mildest winter areas are near the ocean where the moderating effects of the mass of water minimize wide fluctuations in temperature. The site will ideally be frost-free or have a threat of frost only rarely and for short periods. In other cases as with production in protected high tunnel structures, the plastic covering will provide some temperature gain and provide additional protection against frost and wind.



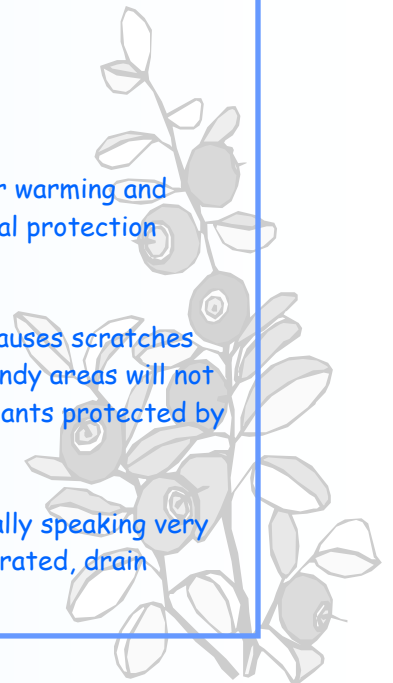
Planting on a hillside will also allow cold air to drain away from the crop on clear, cold nights with the potential for frosts. Sites with good air circulation will also enable mixing of cold air near the surface with warmer air higher off the ground.



Orienting the planting on hillsides facing the winter sun also allows earlier warming and more heat unit accumulation during the fall to spring cooler periods. Additional protection against frost may be aided by overhead sprinklers or fans that mix the air.

High winds cause stress during blueberry establishment, and wind later causes scratches and blisters on developing fruit from nearby leaves and branches. Plants in windy areas will not reach the same levels of vigor and productivity as plants in calmer areas or plants protected by windbreaks.

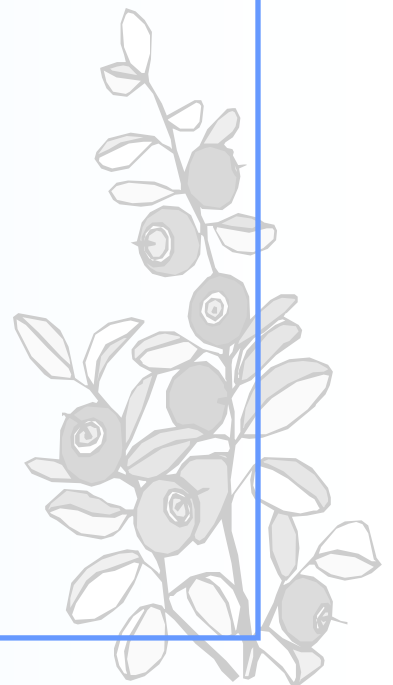
Blueberries can be grown successfully on a range of soil types, but generally speaking very heavy slow to drain clay soils are more problematic. Sandy soils are better aerated, drain



freely and do not store water as well as the heavier soil types, so they will benefit from organic matter addition in the form of compost or well weathered manure and will require more frequent irrigation. The clay soil types require the formation of high beds and incorporation of large amounts of wood waste, sawdust, or rice hulls to improve aeration and drainage.

The selected site should also have access to sufficient water volume to meet the peak irrigation or frost protection needs of the crop and with water quality parameters for acceptable production (see irrigation section).

The growing site should also have access to cooling and packing facilities and markets with road access and infrastructure to move the crop quickly and efficiently, and also complete planting and pruning labor at other times of the year.



Soil Preparation

Blueberries do not tolerate poor drainage and root rot disease, and overall poor vigor will adversely affect blueberries in poorly drained soils. Blueberries should be planted on raised beds in most soil situations. In well drained sandy soils, beds may not be needed, but organic matter should be added. For sandy soils, apply 5 tons per acre of compost or dried manure in 3-4 ft-wide bands over the rows and incorporate the material to a 6-8" depth with a disk or rotovator. This organic material may be combined with sulfur additions used to acidify the soil.

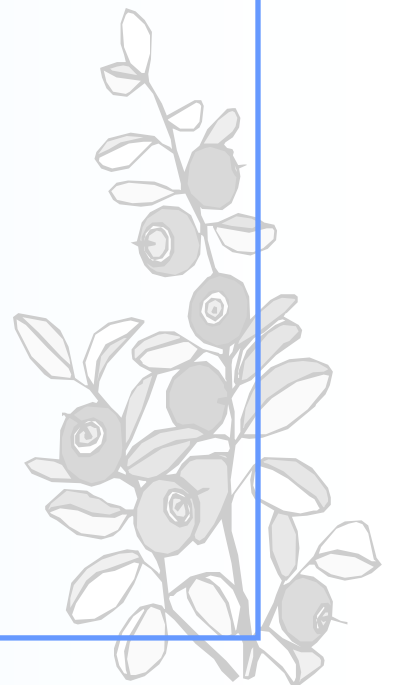
For clay loam or clay soils, additional soil amendment material should be incorporated into the raised bed to help improve porosity, aeration, and drainage. Coarse wood waste, saw dust, or rice hulls are used successfully in California as a soil amendment. In extreme examples - as in Florida where pine bark mulch is plentiful - the plants are established in windrows or pure mulch. In California, liberal amounts of coarse wood waste are routinely applied and incorporated into the soil for blueberries on heavy soils. A minimum of 100 cubic yards of coarse wood waste should be applied and incorporated in a band of 3-4 ft wide over the row. Some growers have also successfully used wood waste filling a V-slit opened in a raised bed and the plants established in the furrow. As with the compost additions in sandy soils, the wood waste can be combined with the sulfur applied to acidify the soil.



The soil should be sampled and analyzed by a reliable soil testing laboratory prior to planting. The soil analysis will determine the optimum amounts of major and minor elements to apply. All of the major and minor elements with the exception of nitrogen should be incorporated into the beds using fertilizer in granular form prior to planting. This will be the most cost-effective method of assuring adequate fertility for the new blueberry planting. It is only necessary to add fertilizer, sulfur, and other amendments in the 4-ft-wide strip of bed centered over the plant row.

The optimum amounts of major and minor nutrients, the sulfur required for acidifying the soil, and any woody amendments can be incorporated into the beds when the beds are prepared prior to planting. This can be done as early as possible prior to plant establishment to allow time for the sulfur to acidify the soil. Preparing the beds ahead of time will also allow time for initial weed control. Irrigate the beds and then allow 2-3 weeks for weeds to emerge and spray with glyphosate (Roundup) or a similar broad-spectrum systemic herbicide. Repeat this a second time and few, if any, further weeds should emerge if the soil surface is not disturbed. At planting, only disturb the soil in the planting holes and mulch the entire surface after planting and few weed problems will follow.

Soils should be retested every 3-4 years for nutrient availability. Additional amounts of major or minor nutrients may be required in later years. Fertilizers can be applied to established plantings by incorporating granular fertilizer under the surface mulch (more economical) or injecting through the irrigation system (greater ease of application and more rapid availability).



Acidifying the Soil

The management of soil pH is important throughout the life of a blueberry planting. Blueberry plants are more vigorous, have more uniform color, and are more productive when growing in acid soil conditions - below pH 5.0. Since pH is frequently between 7 and 8, or even higher in many potential California blueberry growing areas, careful attention to soil pH management is important. In those instances where soil pH is above 8.4, excess sodium may also be a problem, and these soils require additional special management. Poor drainage also limits soil acidification, and the installation of special drainage measures will be needed before soil acidification should be attempted.

To lower the soil pH, acid - usually sulfuric acid - may be applied directly to the soil. Sulfuric acid application is a rapid and effective way to lower the pH but requires specialized equipment and applicators specially trained to handle the potentially hazardous acid. Other acids, such as nitric, phosphoric, etc., can also be used, but they should be used sparingly and paying close attention to the potential for over-application of nitrogen and phosphorus that could result.

More often, elemental sulfur is applied and incorporated in the soil. When elemental sulfur is mixed with moist soil, soil bacteria convert the sulfur to sulfuric acid.

Sulfur is oxidized by bacteria to form sulfuric acid

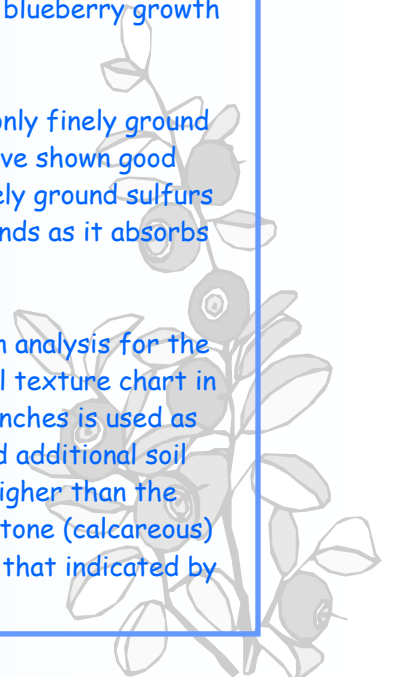


(elemental S + oxygen + water + thiobacillus + time → sulfuric acid)

Soil pH in fields can be quite variable initially following application of sulfur to lower pH. The desired lower pH may not be completely uniform in the bed for several months. It is difficult to get the sulfur uniformly distributed in newly sulfured fields, and the reaction of the sulfur granules can be slow, depending upon the type of sulfur applied and the field conditions. Acidified soils will require continuing pH management for optimum blueberry growth and production throughout the life of the planting.

Apply the sulfur to the soil as early as possible prior to planting and use only finely ground sulfur as opposed to traditional "popcorn" sulfur. The sulfur products that have shown good results in California are Tiger Sulfur 90 and Dispersul, both of which are finely ground sulfurs formed into pellets with bentonite clay for ease of application. The clay expands as it absorbs moisture and breaks apart to disperse the fine sulfur particles.

The amount of sulfur to apply can be determined in a soil laboratory by an analysis for the soil in question or can also be determined by using the current pH and the soil texture chart in Table 1. Normally 2 million pounds representing an acre slice to a depth of 6 inches is used as the basis for calculation of these rates. If beds are raised to 8-12 inches and additional soil volume is moved to establish the beds, this figure may actually be 50-100% higher than the values indicated. If the soil has high levels of bicarbonates and/or free limestone (calcareous) - also common in California - then the S-requirement may also be higher than that indicated by



the chart. Try to correct the figures with an accurate estimate of the total soil volume moved. The sulfur can just be applied to the 4-foot-wide band centered over each row to decrease the costs of acidification. The sulfur should be incorporated uniformly with the soil and any other added amendments.

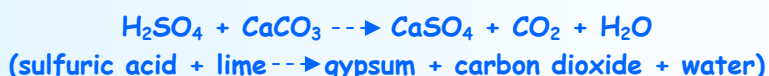
Table 1. Amount of elemental sulfur to apply depending on soil textural class to lower the pH from the indicated pH to 5.0

Initial pH	Soil Textural Class		
	Sand	Loam	Clay
	(lb / 1000 ft ²)		
5.0	4.0	11.7	7.8
5.5	7.7	23.4	35.4
6.0	11.7	34.3	25.9
6.5	14.7	44.7	51.28
7.0	18.6	56.6	84.9
7.5	23.6	59.2	87.5

- these values are for amending a soil to 6 inches. For greater soil volumes as with bedding operations increase the S applied proportionately.

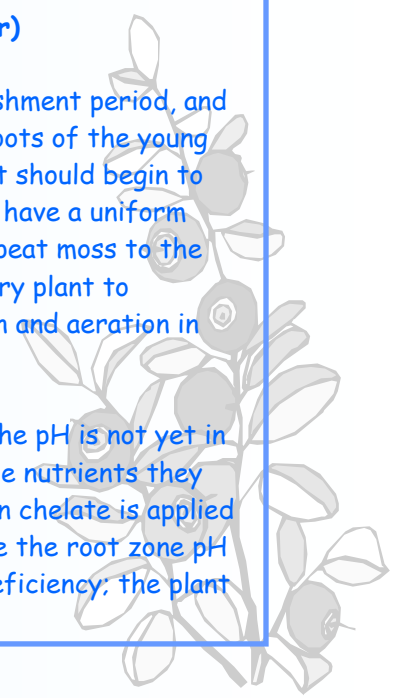
Correcting soil pH when sodium is present involves substituting the sodium with calcium and leaching away the excess sodium so drainage is critical.

This reaction is fairly rapid. One ton of elemental S is equivalent to 5 tons of gypsum.



The management of soil pH is especially critical during the initial establishment period, and growers should pay close attention to the pH environment surrounding the roots of the young plants. If growing conditions are otherwise adequate, a young blueberry plant should begin to initiate new growth 30-60 days after planting, and the foliage overall should have a uniform green to blue-green color down the entire row. The application of sphagnum peat moss to the planting hole at planting provides an ideal environment for the young blueberry plant to establish. The peat moss has an acid pH and also improves moisture retention and aeration in the root zone.

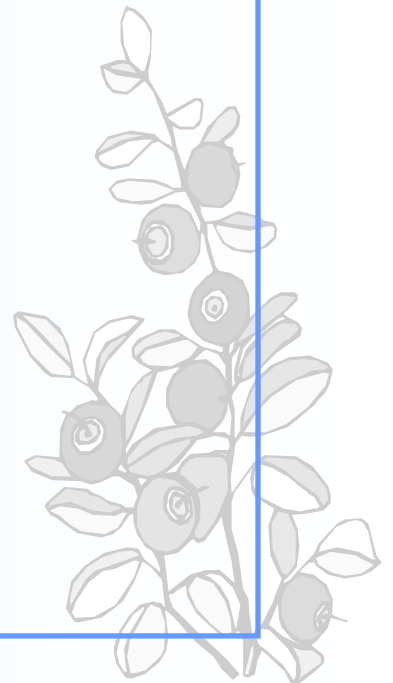
In special circumstances, the plants can be established on a site where the pH is not yet in a desirable range if specific steps are taken to be certain the plants have the nutrients they need. The sphagnum peat is incorporated in the plant hole at planting and iron chelate is applied regularly to the plants as a drench or foliar spray. Blueberries growing where the root zone pH is above 5.5 can show pale green-yellow (chlorotic) new growth due to iron deficiency; the plant



is slow to initiate new growth and the growth is weak. Iron chelate will supply iron to allow chlorotic plants to green-up and begin vegetative growth while the pH of the surrounding soil is falling.

Continuing periodic surface application of more modest amounts of S - 200 to 300 lb per acre per year - will aid in maintaining the desired soil pH. Surface applied S will be most effective during rainy periods as the fine S particles are washed through the mulch and into contact with moist soil. Surface S applications will likely not be effective for as long as six to twelve months following application, so a continued periodic program of S application is the most effective. Application of sulfur to moist soil creates the conditions for soil microorganisms to produce sulfuric acid in the soil. Apply the finest grind of sulfur possible and apply it uniformly.

Test soil pH regularly, and as pH begins to rise, apply S. Acidified irrigation water is a key element of pH management, and it can allow plants to develop normally in many cases while the pH in the surrounding soil is in transition. Sulfuric acid, urea sulfuric acid, and other acids may also be used to acidify the water where the water is alkaline. If alkaline irrigation water is not acidified, the soil pH will increase more rapidly following acidification. The soil will slowly tend to return to its native pH if the acid pH is not regularly maintained with sulfur or acid additions and this trend is accelerated with a high pH irrigation water high in bicarbonates. A soils laboratory can test how much acid of a given type or strength is necessary to lower the pH to the desired level. Acidify the water to a pH of 5.0 or to the point where the total bicarbonates fall below 1.0 meq.



Field Planting

Blueberries can be transplanted in coastal and southern California growing areas at any time during the year if irrigation is available. Temperatures are moderate enough to allow transplanting year around in all but the hotter drier inland areas where the hottest months of May through August should be avoided. The plants will need to be carefully watered following transplanting.

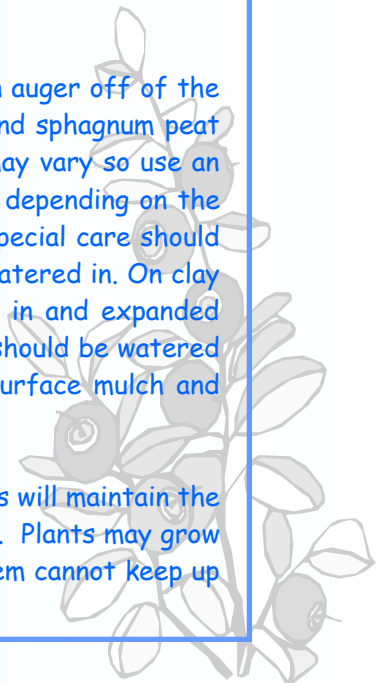
Blueberries should be grown on raised beds in all but the most freely draining sandy soils. This will help improve drainage and protect the plants from soil-borne diseases. Beds are typically 4 ft wide to allow root development in the entire bed area as that root system will eventually support a plant approximately 4 ft in diameter. Blueberries should be planted on 30" spacing between plants in the row by 10 ft spacing from center to center between rows. This will leave a space between beds of approximately 6 ft. Spacing between the rows depends on equipment needs to work, room for spray application, tractor widths, etc. If spraying and other labors will be done by hand, closer row spacing down to 7- 8 ft will increase yields on small acreages.

The preferred plants to establish in the field are typically 12-18 month old plants that include 2-4 small canes and are 12-18" high. Smaller plants - down to 6 month old rooted cuttings - have been successively used for direct field establishment but they require careful management and losses may be higher. Larger plants are more costly but they are less problematic overall and may come into production earlier.

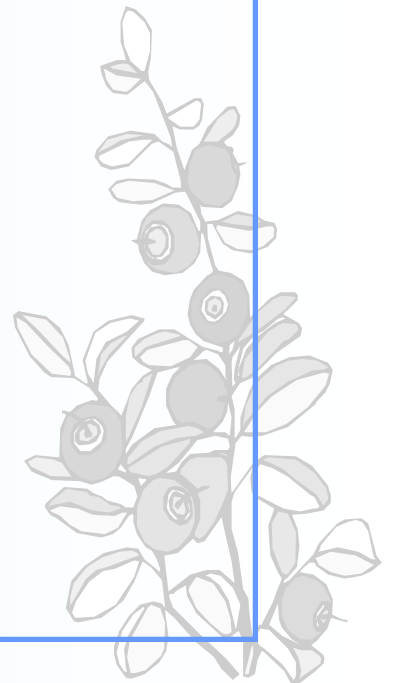
Plants may come from the nursery in pots or grow bags or they may arrive bare root. When planting plants, spread the roots carefully and plant at the same depth as in the nursery. If the root ball holds the shape of the pot or grow bag, carefully tease the roots out of the ball or cut into the ball on four sides and open the root ball up prior to planting. Plants should be planted at or slightly below (0.5") the level they grew at in the pot or nursery. Plants planted too deeply are more susceptible to soil diseases.

The planting hole can be opened by hand on smaller plantings or using an auger off of the tractor PTO unit on larger plantings. The hole should be wider than deep and sphagnum peat moss should be incorporated into the soil in the hole. The pH of the peat may vary so use an acid peat moss at or around pH 5.0. Use $\frac{1}{2}$ - 1 gallon of peat moss per hole depending on the size of the plant. The peat should be soaked in water prior to planting or special care should be taken to assure that the peat is wetted thoroughly when the plants are watered in. On clay or clay-loam soils there may be a benefit to adding additional wood waste in and expanded planting hole and mixing with soil to aid drainage. After planting, the plants should be watered in well and the bed should be top-dressed with 2-3" of wood waste as a surface mulch and mulch should be renewed every 3-4 years as needed.

If roots are not spread out of the shape of the grow bag or pot, roots will maintain the pot shape and J rooting will eventually close off the plant's conductive tissue. Plants may grow well for 3-5 years and abruptly collapse because the limited conductive system cannot keep up



with the moisture needs in warm, dry weather. Once plants are set, prune back smaller and lower branches of plants some to encourage new growth. Plants should initiate growth in 3-6 weeks - slower at cooler times of the year. The sphagnum peat at planting while adding significant costs, allows the plant to get established and begin new growth even where the surrounding soil pH may not be optimum. Do not skimp on planting and planting preparation because the plant responds by initiating rapid and vigorous new growth. If the plant does not initiate new growth check soil and water pH and or irrigation. Check that new shoot growth is green to dark green. Yellow or pale green new growth indicates that pH conditions are marginal and additional acidification of the soil or water is needed. Iron chelate may also be useful in aiding newly set plants to initiate new growth.



Fertilization of Blueberries

Prior to planting. Sample the soil in representative areas of the field and send the sample(s) to a reliable laboratory for analysis of pH, electrical conductivity, and levels of all nutrients except nitrogen(N). Apply granular forms of the important nutrients - phosphorus(P), potassium(K), magnesium(Mg), calcium(Ca), and the micro elements to bring field soil to optimum levels according to the soil analysis procedures. Identify different landscape and soil types and analyze those areas separately.

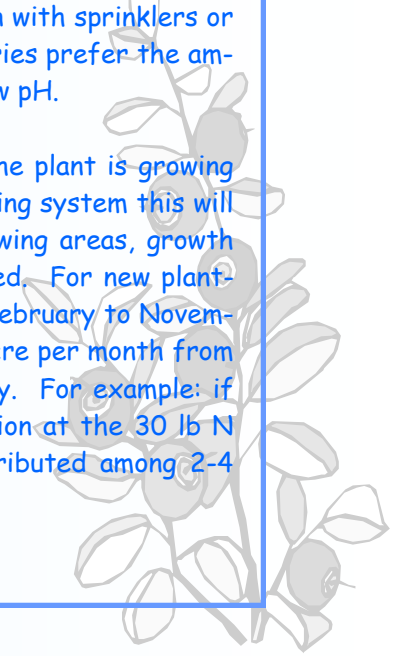
When applying fertilizers and acid amendments, concentrate on amending the bed area - 2 ft either side of the row. The form of phosphorus or potassium to apply is not critical. An economical granular form can be used. For magnesium and calcium sources, avoid limestone, as it will raise the pH. Calcium sulfate (gypsum) is a source of Ca and SulpoMag - sulfate of potassium magnesium - is a source of K and Mg that will not affect the pH. Minor elements can be incorporated preplant also or added through the drip system. Apply sulfur or other acidification materials as needed preplant to alter pH as needed (see section on acidification). The nitrogen analysis is not useful for N fertilizer application rates and timing and N rates are determined by crop, cropping and amendment history, and soil type.

Continuing Maintenance Applications.

Blueberry vegetative development responds dramatically to N applications if other conditions are optimum. Plants will respond to N applications by developing the plant structure on which future yields depend with vigorous new and larger canes. Early in the establishment of a new planting, N is important to develop a large vegetative structure on which to hang fruit. Later, the N is important to re-grow large branches and new canes to support continuing growth and to keep plants vigorous and productive. After the crop is established, the soil should be analyzed every 3-4 years for all of the major plant nutrients except nitrogen.

The preferred way of applying nitrogen is injected through the irrigation system. Soluble N forms may also be applied on the surface near the plant row and irrigated in with sprinklers or rainfall. Use ammonium forms of N (e.g. ammonium sulfate, urea,). Blueberries prefer the ammonium form of N and ammonium is the predominate N form in the soil at low pH.

Apply N regularly (weekly, biweekly, or monthly) during the period when the plant is growing actively. Depending on specific climate conditions, with the evergreen growing system this will be an annual period from 9-12 months. In even the mildest California growing areas, growth slows during December and January and nitrogen fertilization is not needed. For new plantings, apply 150 lb N per acre per year or 15 lb N per acre per month from February to November. After year 3, apply 275 - 300 lb N per acre per year or 30 lb N per acre per month from June to November and 15 lb N per acre per month from December to May. For example: if using ammonium sulfate fertilizer (21% N), for a typical monthly application at the 30 lb N rate apply $30/0.21 = 143$ lb ammonium sulfate per acre per month -distributed among 2-4 weekly or biweekly injections.



One means of acidifying irrigation water is with urea sulfuric acid (US15, Nphuric, or a similar product). Using the urea sulfuric acid will also supply N with each application. The amount applied depends on the initial pH and the bicarbonate content of the water as determined by a laboratory analysis. Typically, water sources for California blueberry production areas require something in the range of 0.20-0.35 gallon of US15 providing 15% N for every 1000 gallons of irrigation water applied to lower the pH to near 5.0. This material weighs 12.65 lb per gallon so this means for each acre-inch of acidified irrigation water used, 10.3 lb of N will be applied.

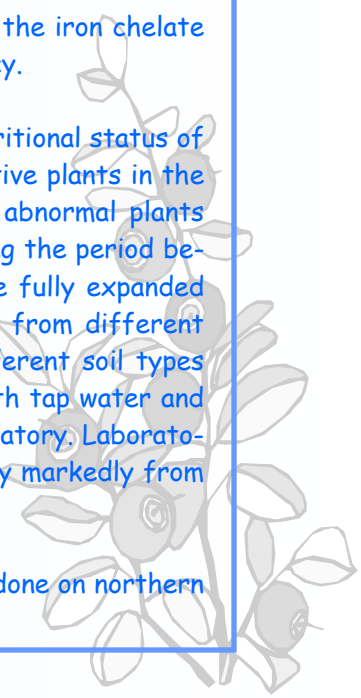
Nitrogen needs tend to fall during the cooler periods of the winter months for field grown blueberries even in the evergreen system. Some growers in mild areas will produce fruit during the mild winter months from open field production. These plants should receive monthly N, but at half the normal rate. If plants are grown in tunnels emphasizing winter production however, N application should continue normally during the winter months.

There are reports that N application can adversely affect flowering and fruit production. Negative effects from N application during the fruiting season have not been documented in California. Blueberries in the evergreen production system and producing over a 2-3 month period need continuing N fertilization to remain vigorous and productive and yield and fruit quality does not appear to decline. Normally N application should continue during flowering and fruiting but at lower levels than the rest of the year when vegetative development is encouraged..

If the soil pH has not fallen below 5.0 in the planted field, apply iron chelate as a foliar, soil drench, or drip application to relieve chlorosis due to iron deficiency. Iron chelate application in the first months after planting enables the plant to begin vigorous vegetative growth while the sulfur is still reacting to lower the soil pH. Chelated iron products are available in formulations of 2-12% iron. Apply according to label rates. In established plantings, leaf tissue analysis will help guide the management of micronutrients. In the absence of a leaf tissue analysis, use the color of the foliage to guide iron chelate application; if the foliage color is pale green to yellow - particularly the new growth - iron deficiency chlorosis is apparent and the chelate treatment should continue. Once the foliage is uniformly green / dark green, the iron chelate can be discontinued and used only as necessary for indications of iron deficiency.

Foliar Analysis. Foliar analysis can also be useful for checking the overall nutritional status of plants and in diagnosing macro or micronutrient deficiencies. Use representative plants in the field unless there are problem areas in which case leaves from normal and abnormal plants should be analyzed separately for comparison. Leaves should be sampled during the period between June and September when plants are actively growing. Choose mature fully expanded leaves on shoots from the current season's growth and collect 45-50 leaves from different branches on random typical plants in the field. Different varieties and different soil types should be sampled and analyzed separately. Leaf samples should be rinsed with tap water and dried with a paper towel then sent to an experienced soil and plant tissue laboratory. Laboratories will often provide containers and shipping instructions. If the results vary markedly from the table below, the nutrients should be added as described above.

Much of the research base for foliar analysis of blueberries has been done on northern



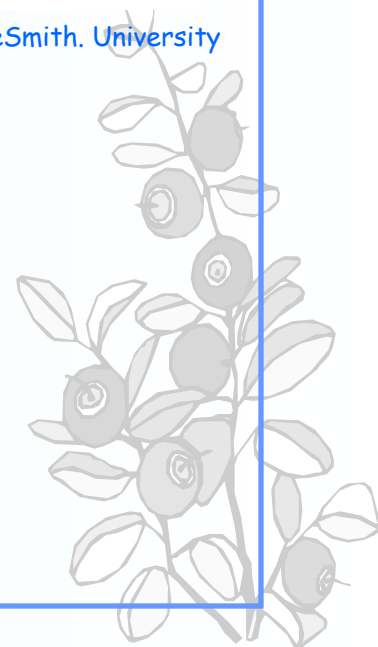
highbush types in northern growing areas or southern highbush types in an environment that includes a dormant period. It is unclear at this point how well the information applies to ever-green growing blueberries but it is the best information currently available. Iron chlorosis in particular needs to be managed carefully in California because of the background of high soil and water pH. Growers need information from tissue levels and soil and water analysis as well as careful monitoring of plant growth to effectively manage potential iron deficiency.

Table 1: Suggested critical nutrient levels in highbush and rabbiteye blueberry leaves

ELEMENT	DEFICIENCY BELOW	STANDARD RANGE FOR		EXCESS ABOVE
		HIGHBUSH AND (RABBITEYE)		
		Minimum	Maximum	
Nitrogen(N)	1.70 %	1.80(1.20)	2.10(1.70)	2.50
Phosphorus(P)	0.10	0.12(0.08)	0.40(0.17)	0.80
Potassium(K)	0.30	0.35(0.28)	0.65(0.60)	0.95
Calcium(Ca)	0.13	0.40(0.24)	0.80(0.70)	1.00
Magnesium(Mg)	0.08	0.12(0.14)	0.25(0.20)	0.45
Sulfur(S)	0.10	0.12(NA)	0.20(NA)	NA
Manganese(Mn)	23 ppm	50(25)	350(100)	450
Iron(Fe)	60	60(25)	200(70)	400
Zinc(Zn)	8	8(10)	30(25)	80
Copper(Cu)	5	5(2)	20(10)	100
Boron(B)	20	30(12)	70(35)	200

NA = not available

Adapted from Blueberry Fertilization in Soil. Gerard Krewer and D. Scott NeSmith. University of Georgia Extension. Fruit Publication 01-1



Pruning Blueberries

Regular pruning of southern highbush blueberry plants should begin in the fourth or fifth year after planting depending on the vigor of the plants. Plants generally also respond to a light initial pruning at planting to stimulate new vegetative growth. Some pruning also takes place on small plants in the early years to remove flowers and fruit to encourage vegetative growth.

Annual pruning should stimulate new growth and keep the plant yielding large crops of big berries. Prune also to remove unproductive, old, diseased, dead, or dying wood. Prune to remove branches that are too low or not upright. Prune to thin out overcrowded canes in the center of the plant. Remove any thin or twiggy wood near the top as time allows and any thin growth from the base of the plant. This will not produce fruit. Upright varieties require less shaping pruning while bushy, and spreading types require pruning training to develop upright growth.

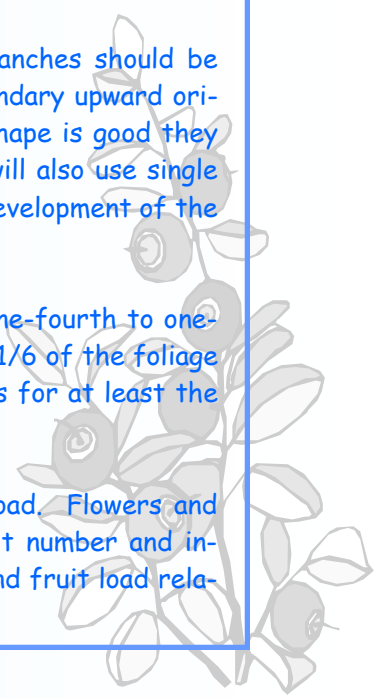
In mild climates, with long growing seasons, the heaviest pruning should come in the summer following harvest. This enables a long period for new vegetative growth before the bud development on the canes changes from vegetative to flower buds in the fall. Fruit forms on lateral branches that develop several months prior to harvest in the evergreen system or during the previous year where dormancy and leaf fall occur. The amount of fruit production depends on these being strong canes. Strong canes that grow in late summer produce fruit buds at their tips. If desired, these canes can be thinned or cut back in winter also but this is at the expense of their fruiting tips.

It is important to determine if new cane production has been sufficient to maintain or increase yield. Prune all wood that has borne fruit the previous year and take these branches back to the next lower strong, young growth. Prune any horizontal, low growing branches or occasionally these canes will develop more upright branches if cut back. Assess the plant and continue with fine pruning and tipping branches that have died back.

Some varieties are more open with some branches that lay out. These branches should be tipped or cut back to upward growing branches. Tipping will cause new secondary upward oriented branches. Other varieties are more upright and while their overall shape is good they may require more thinning to open the center of the plant. Some growers will also use single wire trellises on each side of the row for more spreading plant types to aid development of the upright plant shape.

Prune young bushes at planting time to stimulate new vegetative growth. One-fourth to one-third of the bush may be removed. With more mature bushes, remove up to 1/6 of the foliage area. The flowers and fruit should also be stripped from young, small plants for at least the first 1-2 seasons depending upon the size of the plants.

Winter or early spring pruning is primarily directed at thinning the fruit load. Flowers and fruit may be pruned or stripped from part of a branch to reduce the fruit number and increase the fruit size. The amount of thinning will depend upon the variety and fruit load rela-



tive to the vegetative area of the plant. Larger plants and more vigorous branches can support heavier fruit load.

Beginning in year 5 or 6 depending on plant vigor, the oldest cane should be cut back to the base at or near ground level. Allow a new cane to replace this cane and thus renew the entire plant every 5 years if there are an average of five primary canes per plant



Fig. 1. Branching from pruned canes.



Fig. 2 Branching from pruned back cane.



Fig. 3. Vigorous growth of branching canes following summer pruning.

