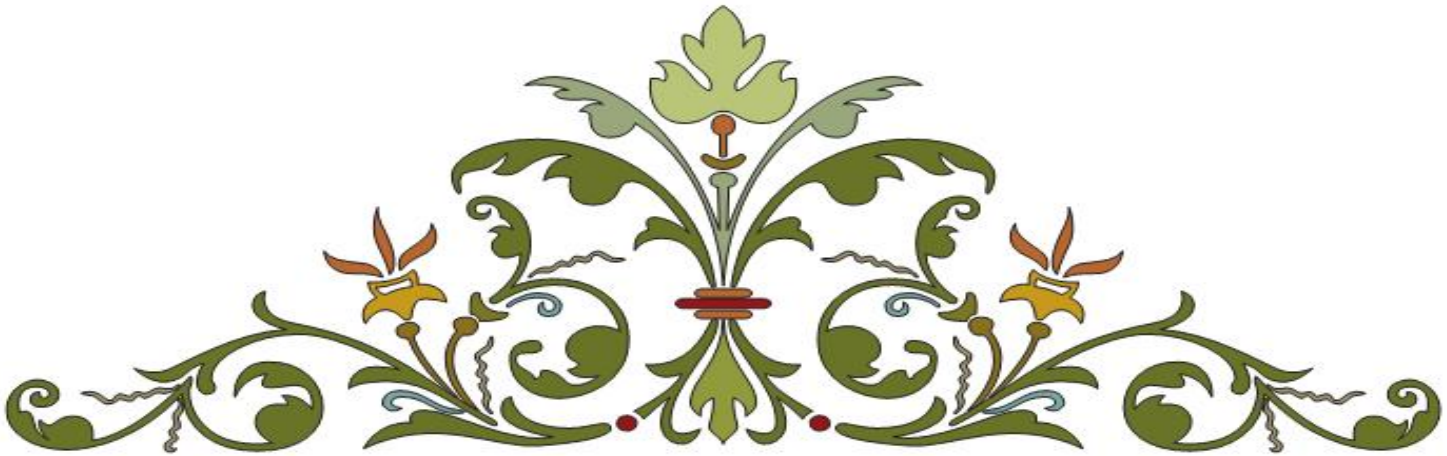
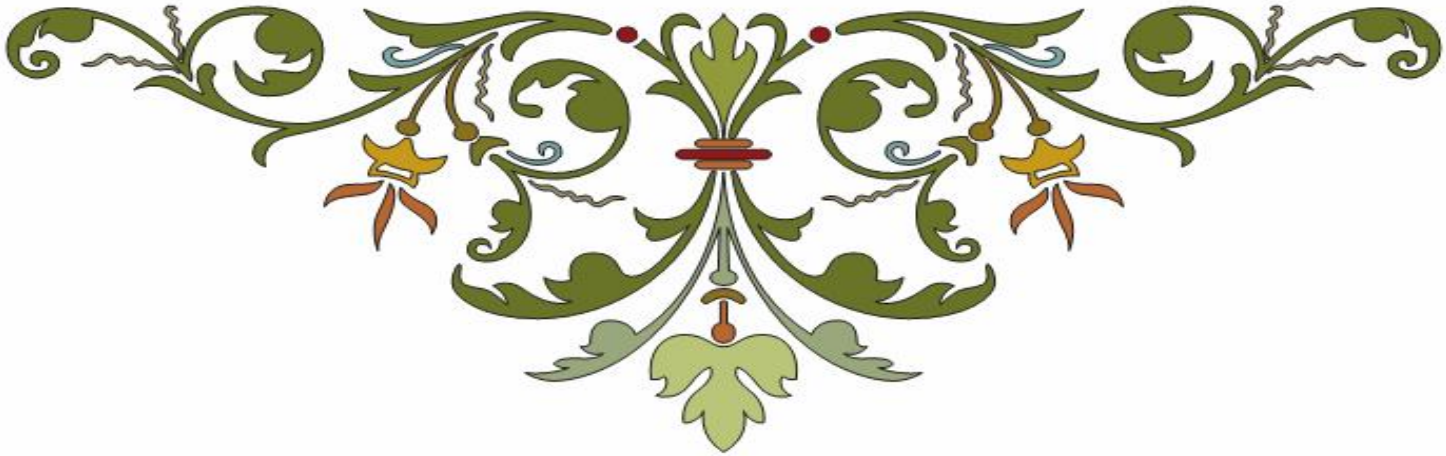
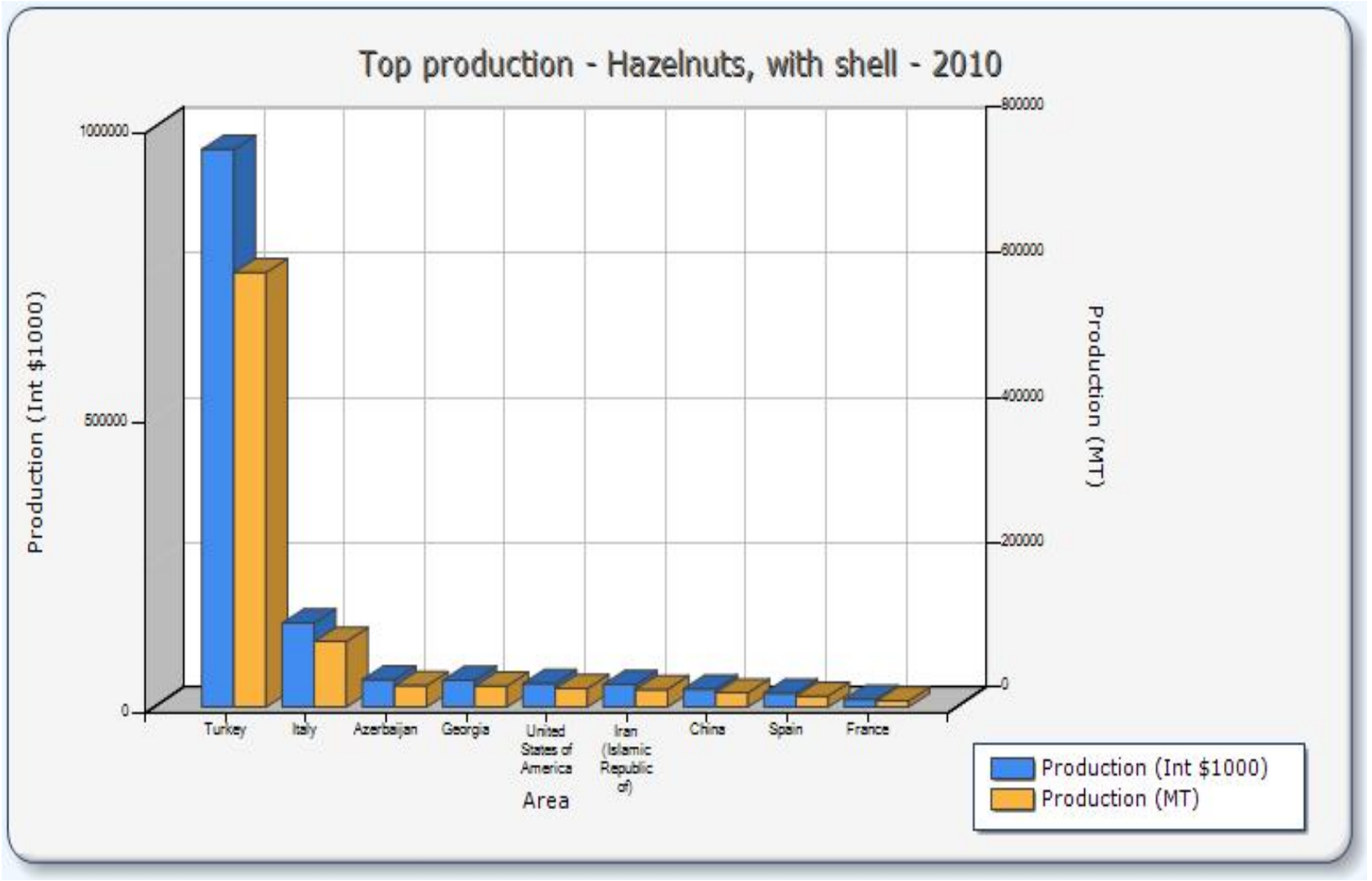


In the Name of God



Corylus avellana

Rank	Area	Production (Int $1000)	Flag	Production (MT)
1	Turkey	961744	*	600000
2	Italy	144694	*	90270
3	Azerbaijan	47212	*	29454
4	Georgia	46163	*	28800
5	United States of America	40715	*	25401
6	Iran (Islamic Republic of)	38950	*	24300
7	China	31256	*	19500
8	Spain	24203	*	15100
9	France	13284	*	8288
10	Croatia	5342	*	3333
11	Kyrgyzstan	5289	*	3300
12	Poland	4007	*	2500
13	Greece	2083	*	1300
14	Belarus	1923	*	1200
15	Tajikistan	1763	*	1100
15	Uzbekistan	1763	*	1100
17	Russian Federation	1282	*	800
18	Armenia	801	*	500
19	Mongolia	625	*	390
20	Republic of Moldova	480	*	300


Top production - Hazelnuts, with shell - 2010
Production (Int $1000)
1000000
500000
0
800000
600000
400000
200000
0
Production (MT)
Turkey
Italy
Azerbaijan
Georgia
United States of America
Iran (Islamic Republic of)
China
Spain
France
Area
Production (Int $1000)
Production (MT)

سطح زیرکشت، میزان تولید و عملکرد محصولات باغی (دایمی) کشور
به تفکیک محصول در سال ۱۳۸۷

جدول شماره ۲-۱ ((واحد: هکتار))

نام محصول	سطح بارور			سطح غیربارور			جمع سطح بارور و غیربارور		
	آبی	دیم	جمع	آبی	دیم	جمع	آبی	دیم	جمع
پسته	۳۷۹۱۷۶,۷	۲۱,۳	۳۷۹۱۹۸	۵۱۸۹۶,۱	۵۵,۹	۵۱۹۵۲	۴۳۱۰۷۳,۸	۷۷,۳	۴۳۱۱۵۰
بادام	۸۹۰۵۱,۱	۵۷۶۱۰,۷	۱۴۶۶۶۱,۸	۲۱۶۵۱,۳	۱۶۹۸۱,۶	۳۸۶۳۲,۹	۱۱۰۷۰۲,۵	۷۴۵۹۲,۳	۱۸۵۲۹۴,۷
گردو	۱۵۰۵۱۲,۳	۵۲۵۲,۴	۱۵۵۷۶۴,۷	۵۴۳۹۳,۵	۳۵۱۱,۶	۵۷۹۰۵	۲۰۴۹۰۵,۸	۸۷۶۳,۹	۲۱۳۶۶۹,۷
فندق	۱۳۰۵۸,۴	۹۷۸۸,۹	۲۲۸۴۷,۳	۱۴۷۸,۸	۸۶۶	۲۳۴۴,۸	۱۴۵۳۷,۲	۱۰۶۵۴,۹	۲۵۱۹۲,۱

سطح زیرکشت، میزان تولید و عملکرد محصولات باغی (دایمی) کشور
به تفکیک محصول در سال ۱۳۸۷

ادامه جدول شماره ۲-۱ ((واحد: تن – کیلوگرم))

نام محصول	تولید			عملکرد	
	آبی	دیم	جمع	آبی	دیم
پسته	۱۹۲۲۶۶	۳	۱۹۲۲۶۹	۵۰۷,۱	۱۵۸,۹
بادام	۱۰۲۸۸۲	۲۳۷۹۷	۱۲۶۶۷۹	۱۱۵۵,۳	۴۱۳,۱
گردو	۳۶۲۱۴۳	۱۷۰۲۷	۳۷۹۱۷۱	۲۴۰۶,۱	۳۲۴۱,۹
فندق	۱۸۶۰۷	۱۱۶۳۶	۳۰۲۴۳	۱۴۲۴,۹	۱۱۸۸,۷

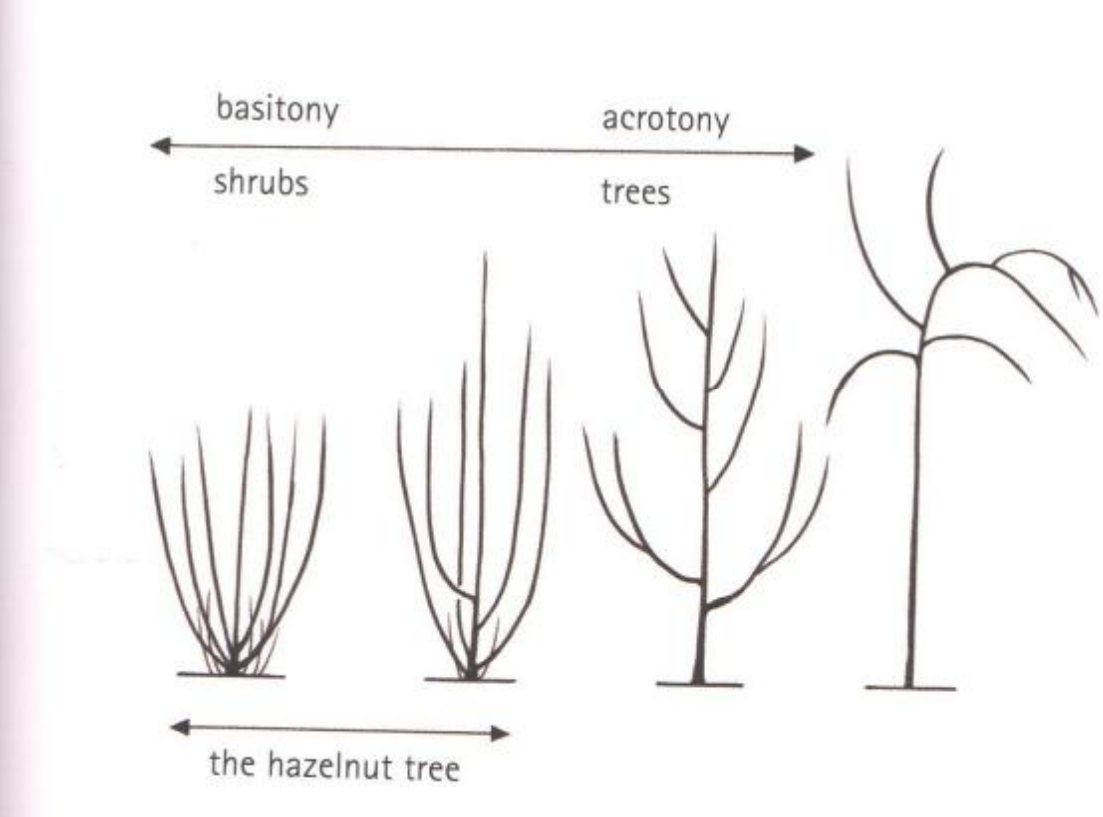
GROUP	SPECIES	AREA OF DISTRIBUTION
Avellana group (shrub)	*Corylus avellana* L.	Europe, Anatolia, Caucasus, Urals
	Corylus maxima Mill.	Anatolia, Eastern Europe
	Corylus Americana Marsh.	North America
	Corylus heterophylla Fish.	Manchuria, Korea, Japan
Cornuta group (shrub)	*Corylus cornuta* Marsh.	North America
	Corylus californica Rose	North America
	Corylus sieboldiana Blume	Mongolia, Manchuria, Korea, Japan
Colurna group (tree)	*Corylus colurna* L.	Eastern Europe, Anatolia, Caucasus to the Himalayas
	Corylus chinensis Franchet	Central China
	Corylus jacquemontii Decaisne	Afghanistan, northern India
	Corylus papyracea Hickel	China
	Corylus ferox Wallich	Intermediate zone of the Himalayas central China, Nepal, Sikkim

Type of organ	Catkin	Inflorescences (female)	Vegetative buds
Number of hours at T < 45° F	< 100 to 365-480	480-600 to 1170-1255	600-680 to 1170-1255

Frost damage on a shoot

Basitonic growth throughout the tree

The hazelnut tree is a shrub



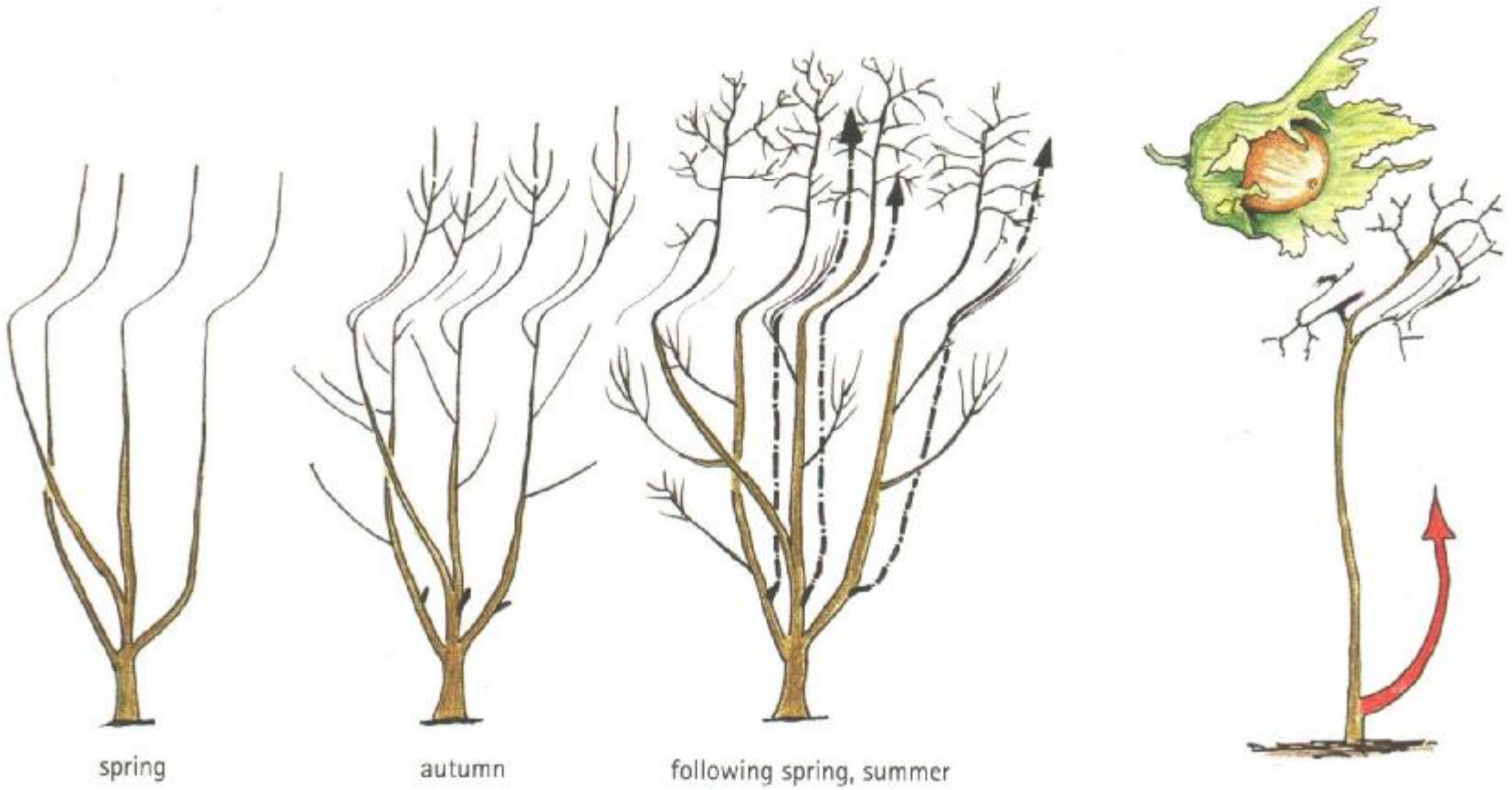
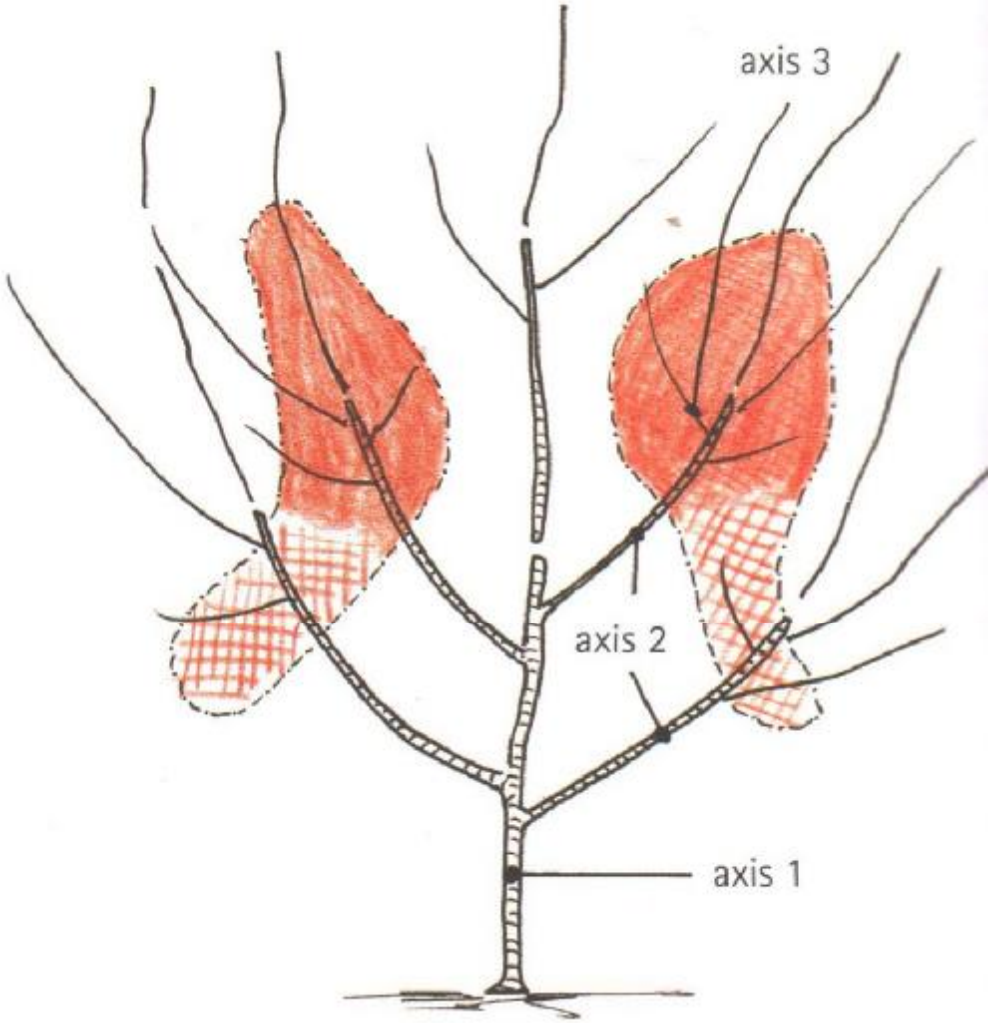


Fig. 2. The process of epicormic branch formation on hazelnut trees: basitonic reiterations often arise when there is abundant fruiting.

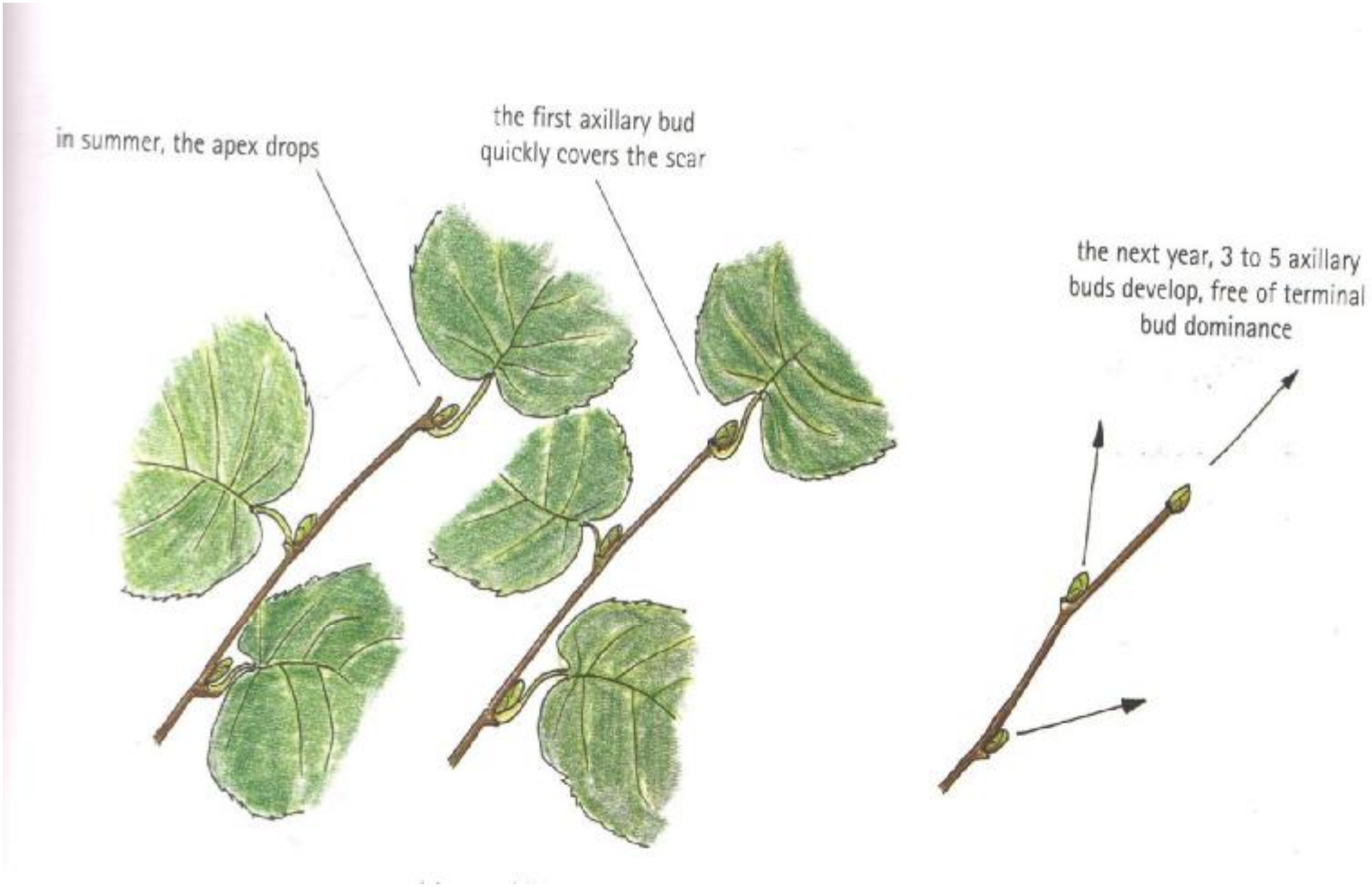


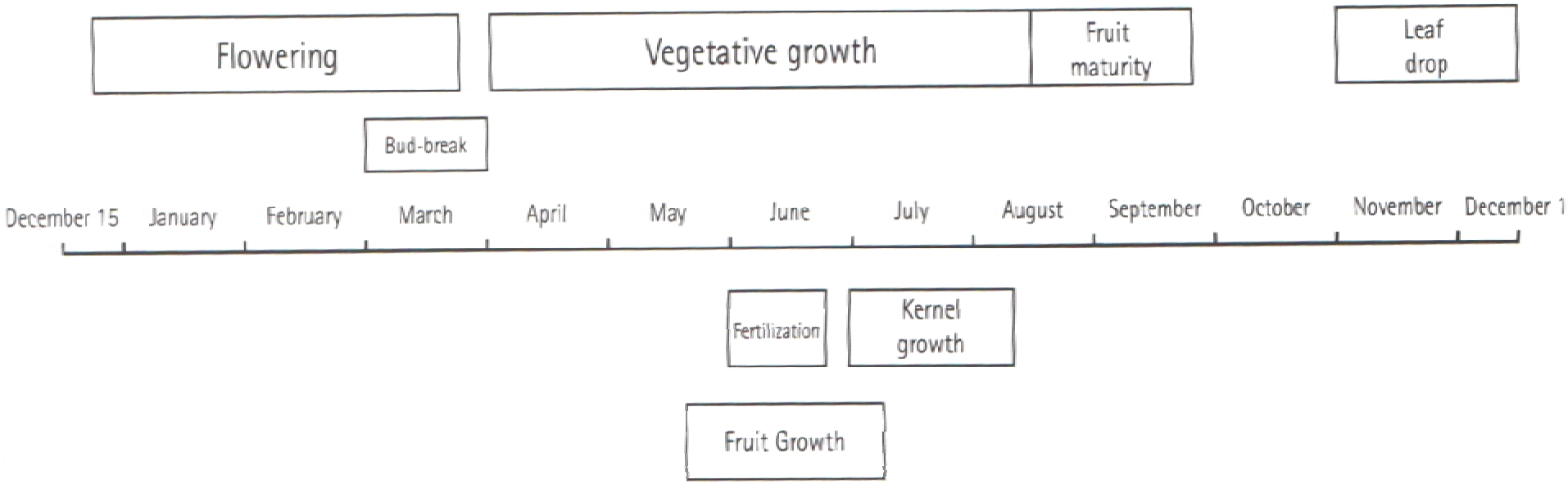
The areas of first fruiting on a tree that was not cut back at planting

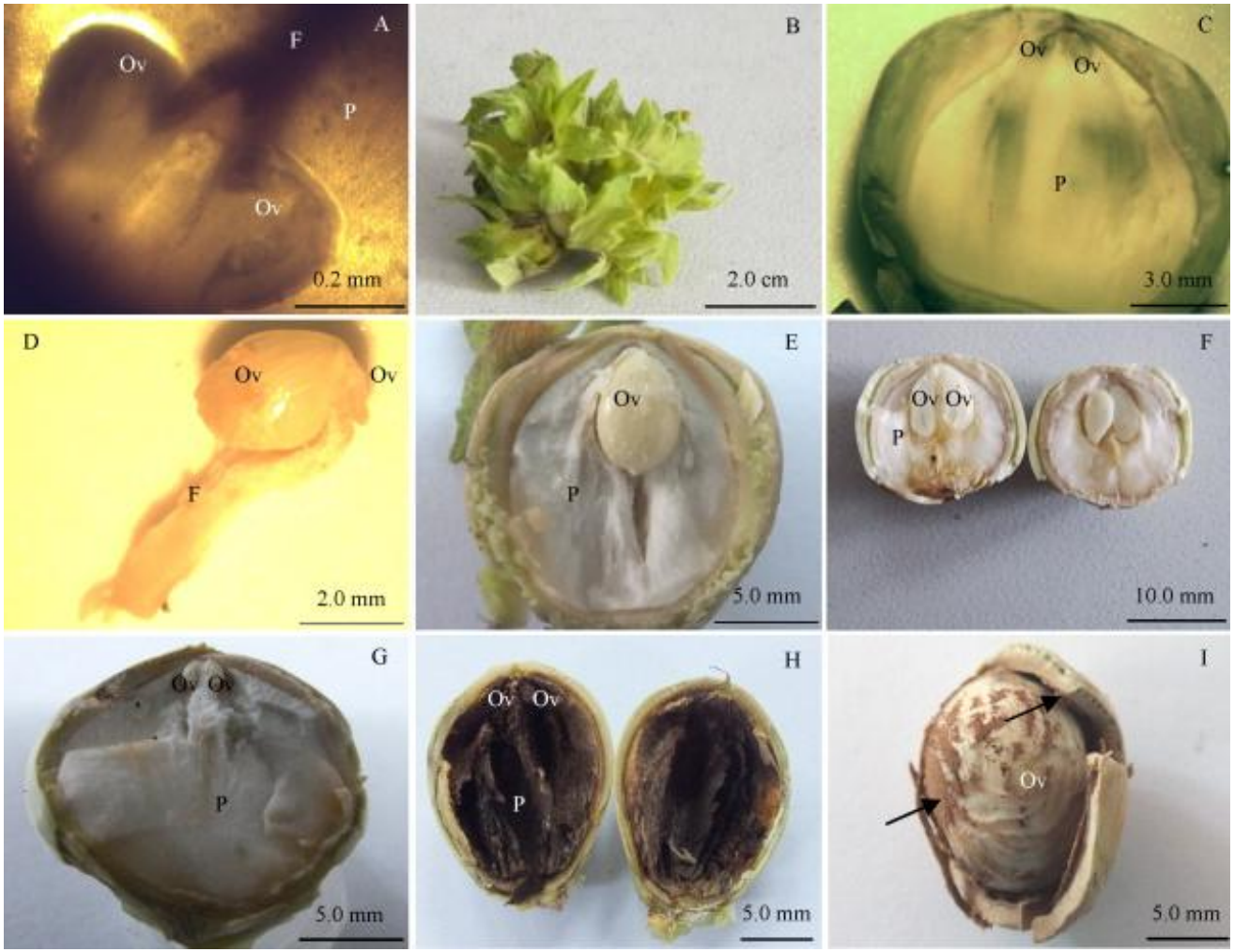

© G.A. Cooper


Property of Edible Landscaping LLC


catkin scar


in summer, the apex drops
the first axillary bud quickly covers the scar
the next year, 3 to 5 axillary buds develop, free of terminal bud dominance


Flowering
Vegetative growth
Fruit maturity
Leaf drop
Bud-break
December 15
January
February
March
April
May
June
July
August
September
October
November
December 1!
Fertilization
Kernel growth
Fruit Growth



Ovule filling and blank fruit formation. (A) Two ovules formed in an ovary, 22 May; (B) fruit cluster, 23 June; (C) fruit at early development stage, with one developed and one undeveloped ovule. Most space inside the fruit shell was filled with parenchyma, 2 July; (D) two ovules attached with funiculus, one ovule developed (left) and the other one (right) cease development, 12 July; (E) rapid expanding ovule, only one ovule developed in one kernel, 2 August; (F) double-kernel fruit, two well developed ovules, 2 August; (G) blank fruit. Two ovules ceased development and most of the inside shell was filled with parenchyma, 2 August; (H) blank fruit at harvest. Two undeveloped ovules were left inside the shell, 22 August; (I) normal filled kernel at harvest. Blown parenchyma residue was shown by arrows, 22 August. P: parenchyma; F: funiculus; Ov: ovule.

Scientia Horticulturae 136 (2012) 128–134

Contents lists available at SciVerse ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

The relationship between reproductive growth and blank fruit formation in *Corylus heterophylla* Fisch

Jianfeng Liu*, Yunqing Cheng, Kun Yan, Qiang Liu, Zhanwu Wang

College of Life Sciences, Jilin Normal University, Siping City of Jilin Province 136000, China

ARTICLE INFO

Article history:
Received 14 November 2011
Received in revised form 7 January 2012
Accepted 10 January 2012

Keywords:
Hazelnut
Blank fruit
Embryo abortion

ABSTRACT

The reason leading to the high blank fruit ratio of *Corylus heterophylla* Fisch was elucidated by investigating pollen compatibility, ovule and embryo development. It was showed that the female flowers bloomed in the middle of April and the ovary did not develop until 1 month later. In late May, two ovules were found in an ovary. On 22 June, the ovule wall differentiated into integument, and nucellus endosperm were clearly observed in the ovules, suggesting the starting of fertilization event. Globular, heart, torpedo and cotyledon embryo developed step by step from 28 June to 12 July. The ovule grew rapidly in filled fruit since 12 July. Ovule in blank fruit ceased growth from 12 July although the full embryo with cotyledon could be observed. The blank fruit could be distinguished from the filled one for its undeveloped ovule and large amount of parenchyma. There was no significant difference in ovary size between the filled and empty nuts, but the weight of blank nut was only about one half of the filled one. It is concluded that formation of blank fruit of *C. heterophylla* Fisch is closely related to embryo abortion, but not incompatibility between the pollen and stigma.

Available online at www.sciencedirect.com
ScienceDirect
Scientia Horticulturae 113 (2007) 208–215
SCIENTIA HORTICULTURAE
www.elsevier.com/locate/scihorti

An investigation of the relationship between reproductive growth and yield loss in hazelnut

Neriman Beyhan [a,*], Dilek Marangoz [b]

[a] *Ondokuz Mayıs University, Faculty of Agriculture, Department of Horticulture, 55139 Samsun, Turkey*
[b] *Ondokuz Mayıs University, Vocational Training School of Samsun, Department of Greenhouse Management, 55139 Samsun, Turkey*

Received 7 December 2005; received in revised form 13 October 2006; accepted 21 February 2007

Abstract

This study was carried out in Samsun during a 2-year period to examine the relationship between reproductive and yield loses in the 'Tombul' and 'Palaz' hazelnut cultivars. In hazelnuts, male and female flowering occur in winter after the breaking of inflorescence dormancy. In the present study, growth of the ovary of the hazelnut started in April and continued until mid-June. At the time of flowering the ovary did not form. The ovule growth showed a rapid increase at the end of June. Change in the diameter of the ovary and ovule with time showed a simple sigmoid growth curve. Fertilization occurred during the period between mid-May and the beginning of June, namely, 3.5–5 months after pollination. At this time, the diameter of the nut was 9.54 mm. Twin kernel was not observed. The ratio of double kernels was close to zero. The time period from fertilization to harvest was 89 days in 1997 and 96 days in 1998 for Tombul cultivar. For the Palaz, this period was 84 days in 1997 and 86 days in 1998. The rate of pistillate flower clusters which dropped in April–May was more than those dropped in June–August.

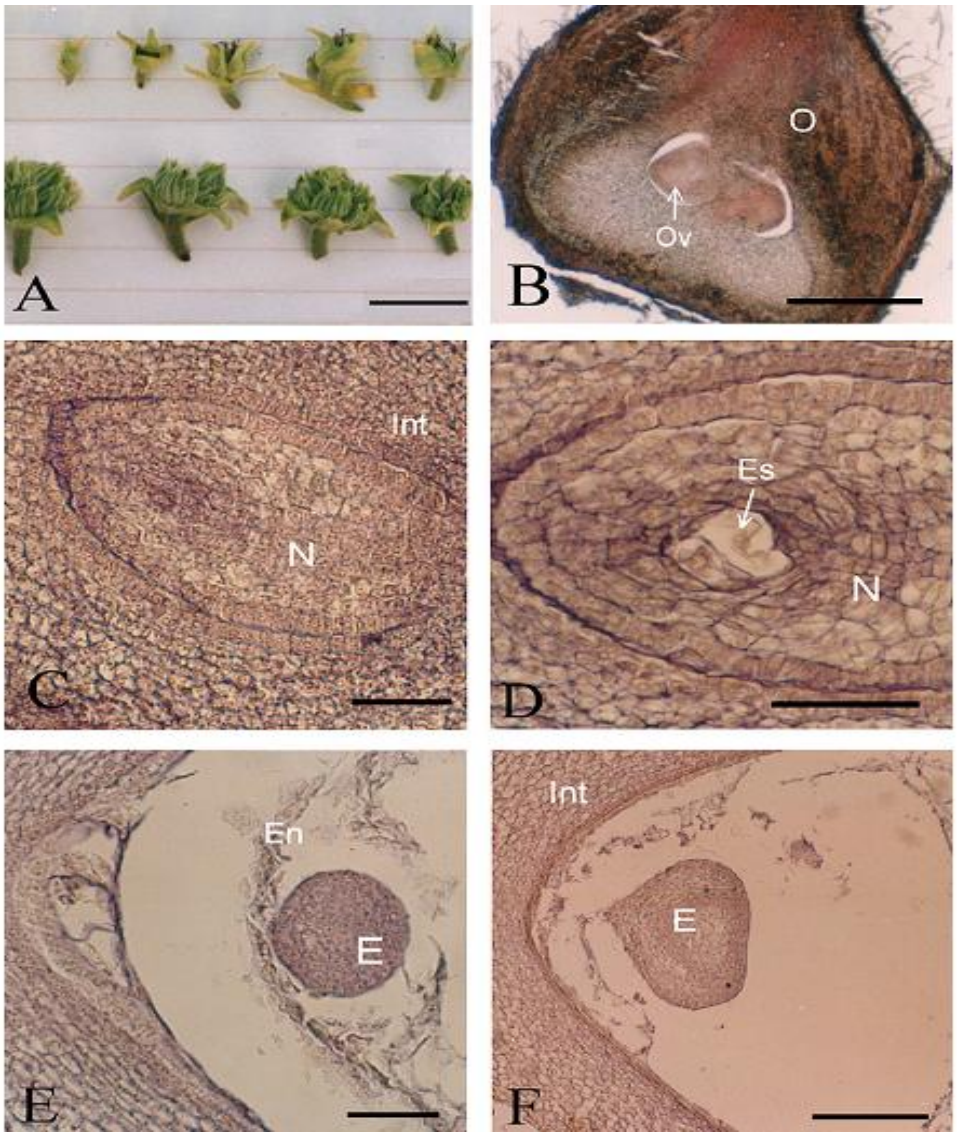


Fig. 1. Early stage ovary, ovule and embryo development. (A) Macrophotograph of the clusters from female flowers with non-developed ovary (above), and developing some of the ovaries (below), 30 April. (B) Micrograph of the ovary longitudinal section. The two ovules are visible on the placenta, 7 May. (C) Nucellus forming, 21 May. (D) Nucellus with embryo sacs, 28 May. (E) Globular embryo and cellular endosperm, 4 June. (F) Heart-shaped embryo, 13 June. Bars A, 1 cm; B, 0.5 mm; C–E, 0.05 mm; F, 0.2 mm (Es: embryo sac; O: ovary; Ov: ovule; N: nucellus; Int: integument; E: embryo; En: endosperm).

According to our result, difference in the percentage of the pistillate flower cluster dropping between years in the same cultivar was evident. One of the reasons as to the early clusters dropping was lack of pollination. Thompson (1967) clearly indicated that growth of the ovary was dependent upon pollination. If growth is arrested in all of the flowers in a cluster, the cluster withers and falls in late April or May. Both Thompson (1967) and Beyhan and Odabaş (1996) reported that some ovaries could not grow more than 0.5 mm and these pistillate flowers dropped in April and May. On the other hand, while pollination is necessary to initiate ovary development; only a small percentage of the pollinated pistils develop into a full sized nut.

In the present study, in May, it was determined that the average number of functional ovaries in one cluster was 40–60% for the Tombul cultivar and 40–55% for the Palaz cultivar. These results showed a similarity with the findings of Beyhan (1995) in which 45–60% of the ovaries could not develop further. Germain et al. (1978) and Germain (1994) reported that, shortly after leafing, up to 70% of the flowers can stop growing.

When all the flowers in a cluster are affected by this phenomenon, the cluster drops by the end of April or in May. However, Dimoulas (1979) reported that, in general, these drops were not caused by a lack of pollination or by competition between flowers within the same inflorescence but were closely related to apical dominance which occurs along the 1-year-old shoots and the peduncles of catkins.

The ovaries and ovules of pollinated pistillate flowers continue to develop until fertilization. But not all pistillate flowers are fertilized. The diameter of the ovary was found to be 9.54 mm during this period in our study which is a critical phase for the hazelnut. As Silva et al. (1996) stated, ovules will not develop in non-fertilized ovaries and blank fruits form. On the other hand, even if fertilization occurs, the ovule and development of the embryo may cease at various times during the period from fertilization to harvest. The clusters with ovaries of both type drop. If even one ovary is fertilized and it develops into a cluster, that cluster will not drop.

Mehlenbacher et al. (1993) reported that nut and kernel defects are serious problems for the hazelnut. These include blanks, brown stain disorder, doubles, moldy kernels, kernels with black tips, shriveled kernels and poorly filled nuts. Brown stain, a poorly understood disorder that leads to kernel abortion, appears sporadically in Oregon and can result in severe crop loss. Poorly filled nuts and shriveled kernels are defects in which the kernel is smaller than in size. Small kernels are most common when the crop load is heavy or trees are stressed during the period of rapid kernel growth.

Lagerstedt (1977, 1985) reported that cluster droppings were caused by the genetic constitution of the cultivar, alternate bearing habit, pollen source, sexual incompatibility, cultural practices (nutritional deficiencies, lack of irrigation, disease and insect pests), and environmental conditions. On the other hand, Beyhan and Marangoz (1999) reported that the fruit cluster drops which occurred in June were mostly due to nutritional deficiencies while the cluster drops which occurred in July or August were caused by insufficient soil moisture and nutritional deficiencies.

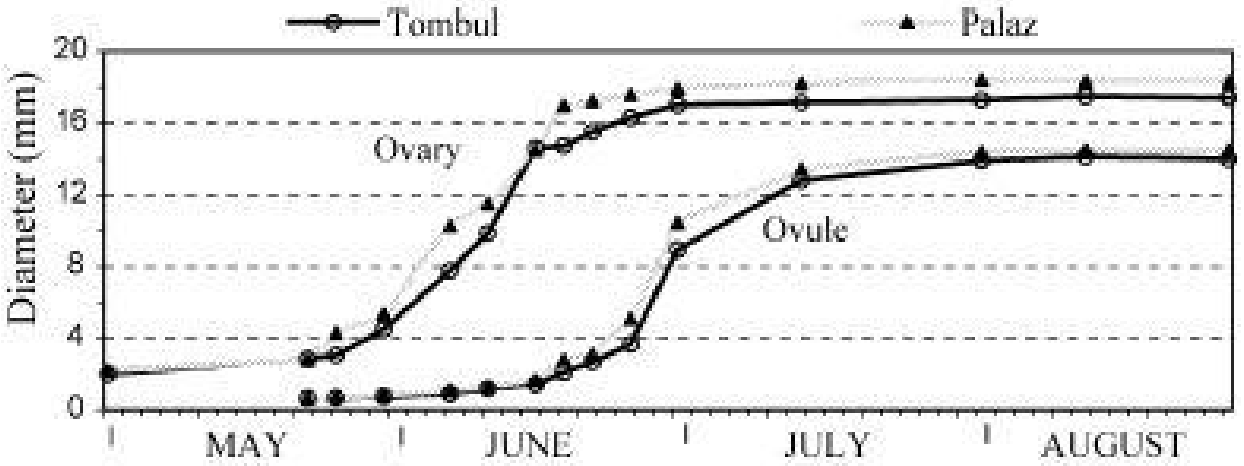


Fig. 3. Growth curves of ovary and ovule diameter of equivalent sphere for Tombul and Palaz hazelnut in 1997.

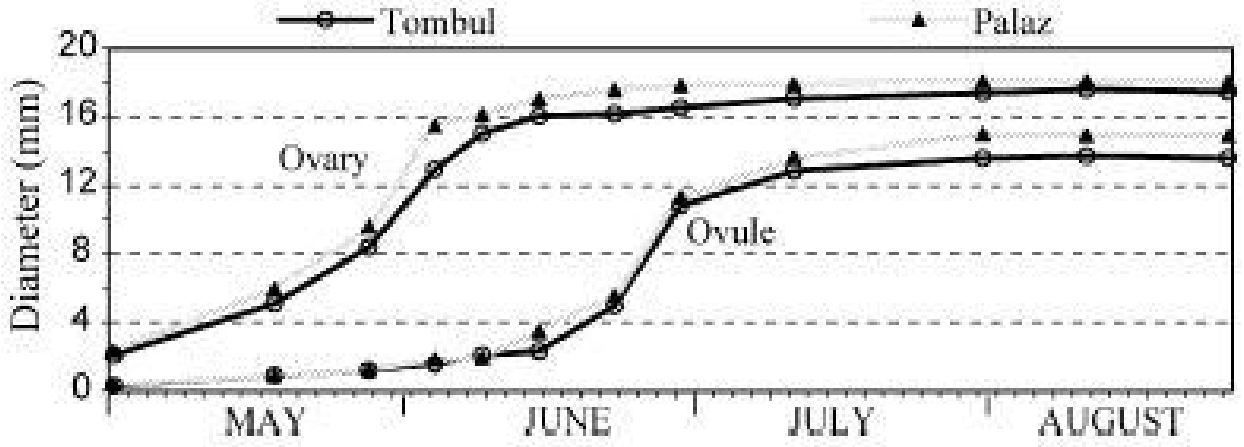
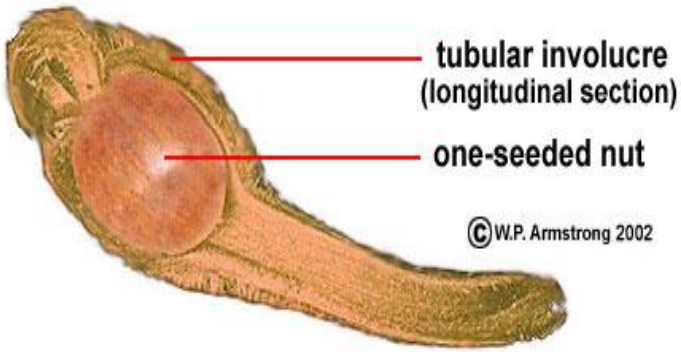
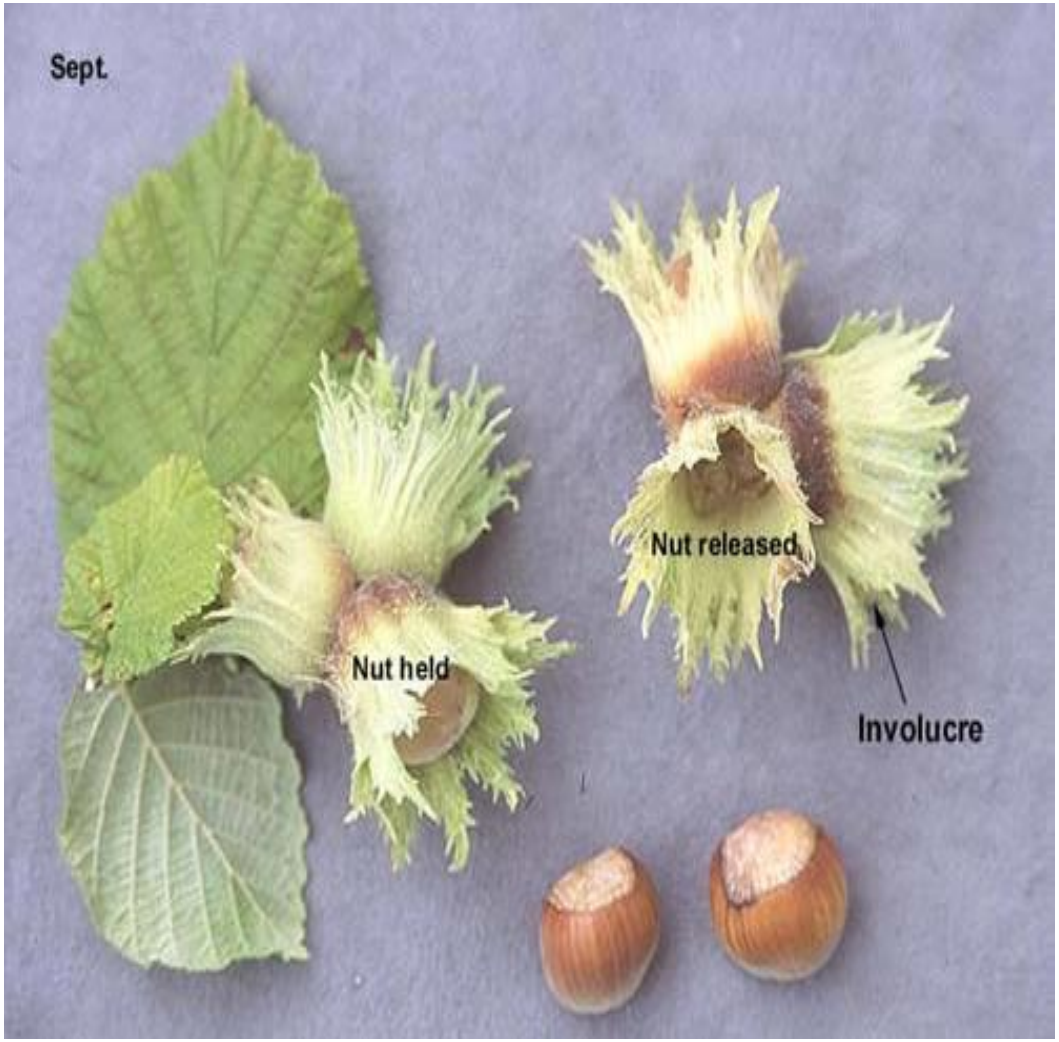


Fig. 4. Growth curves of ovary and ovule diameter of equivalent sphere for Tombul and Palaz hazelnut in 1998.

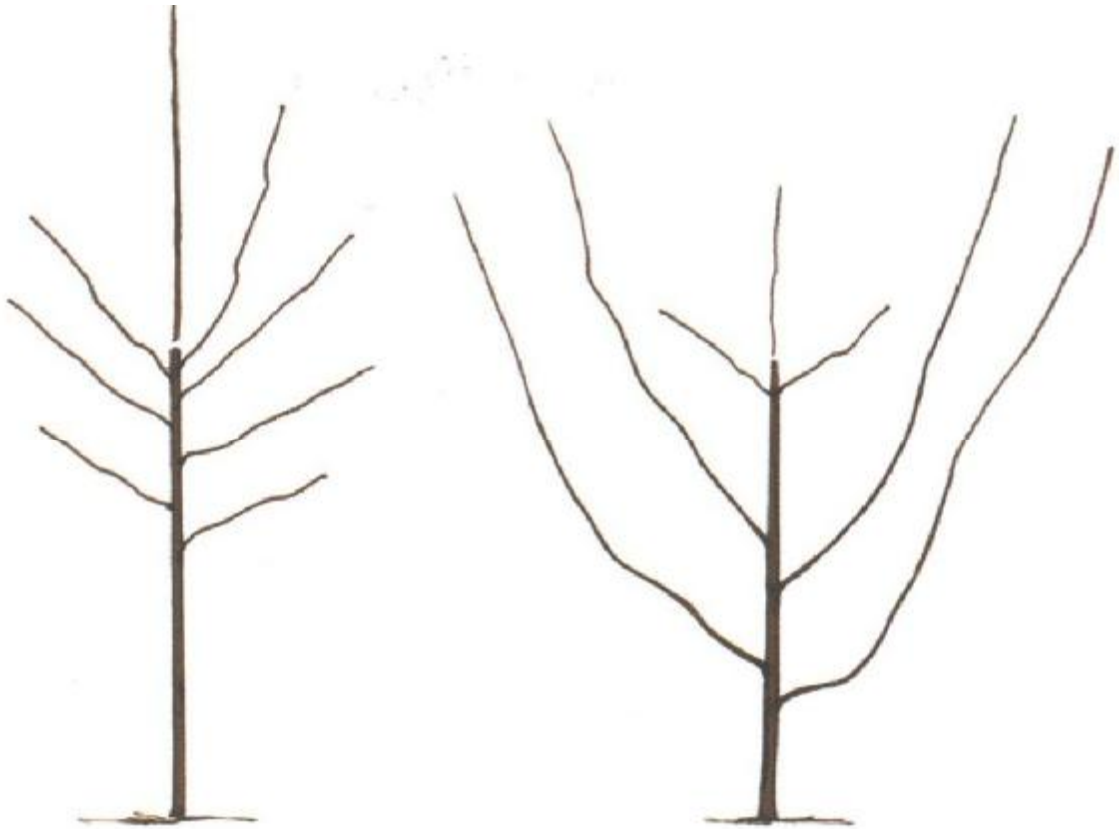


Beaked Filbert or Hazelnut (*Corylus cornuta*)

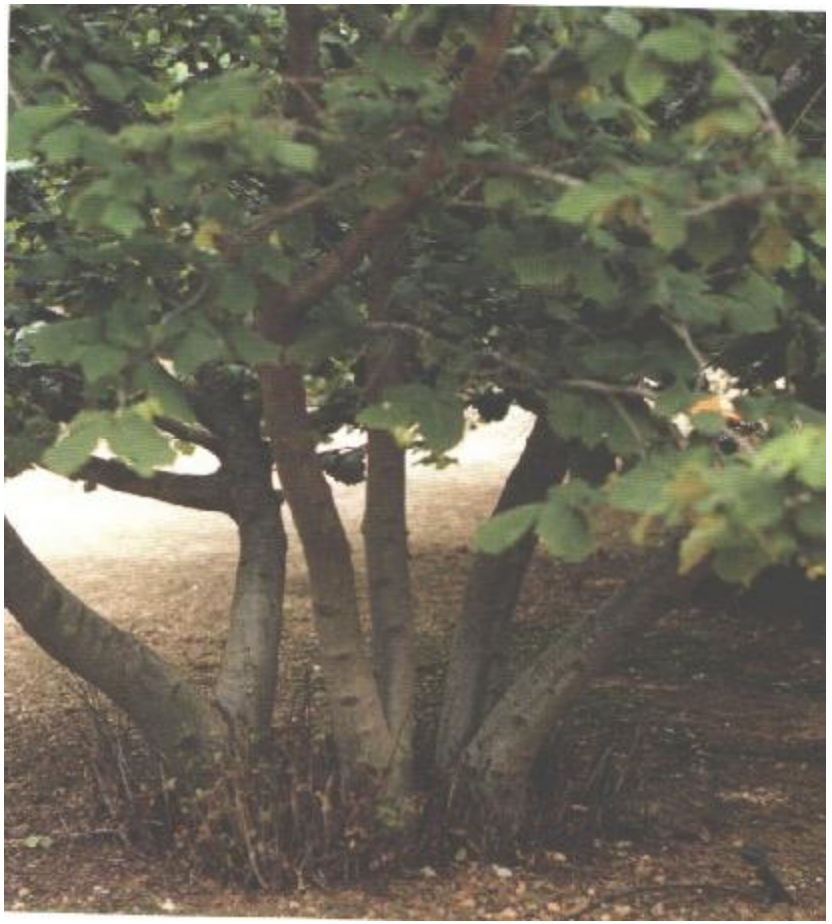


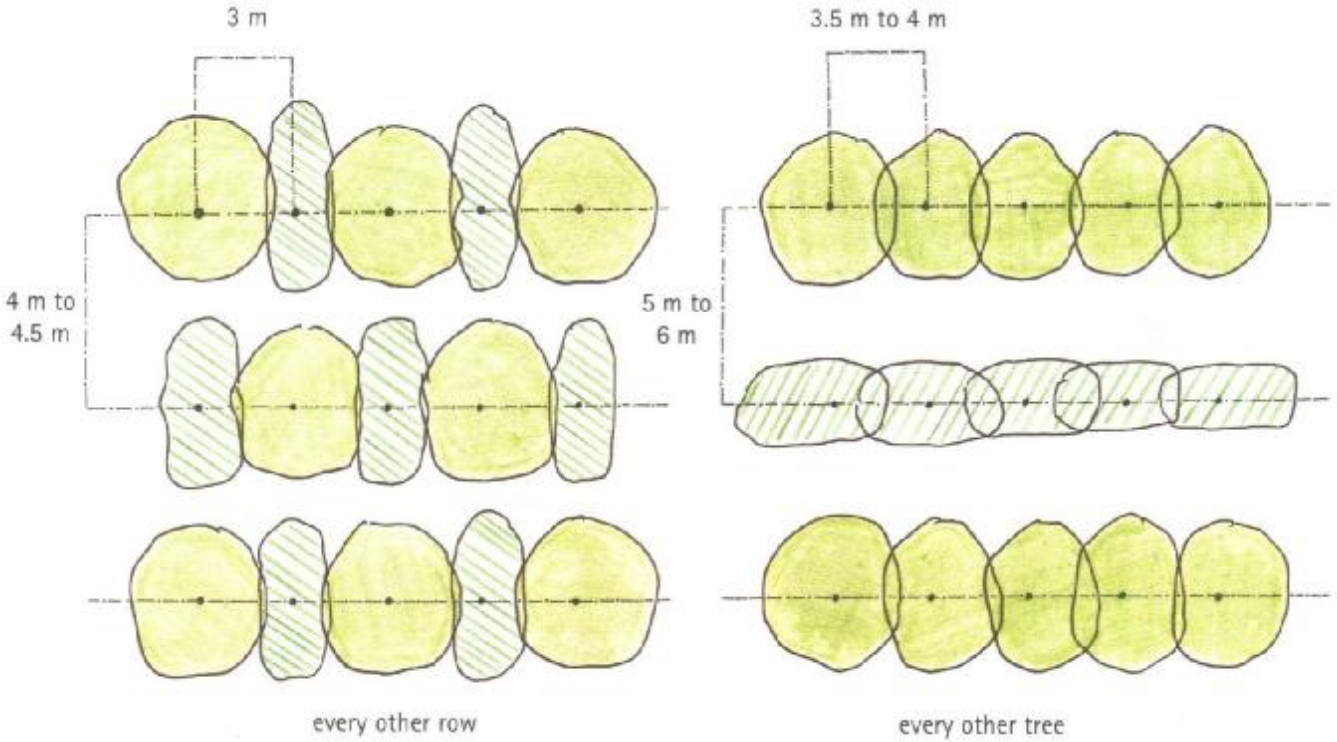

BEFORE


AFTER



Two behaviors of first year hazelnut trees




3 m
4 m to
4.5 m
every other row
3.5 m to 4 m
5 m to
6 m
every other tree

Almond

SCIENTIFIC NAME : *Prunus communis*
Prunus dulcis
FAMILY: *Rosaceae*
CHROMOSOME NUMBER: *2n= 28*

ORIGIN AND DISTRIBUTION:

- **Originated from south west and central Asia**
- **Major Growing Countries: California, Spain, Italy, Greece, Turkey, India**
- **California is the leading producer of almond in world with 489,879,76 ton**
- **India's production : 1,179,34 ton**
- **major states in India :**

•Jammu and Kashmir (Almond is the state tree of Jammu and Kashmir)

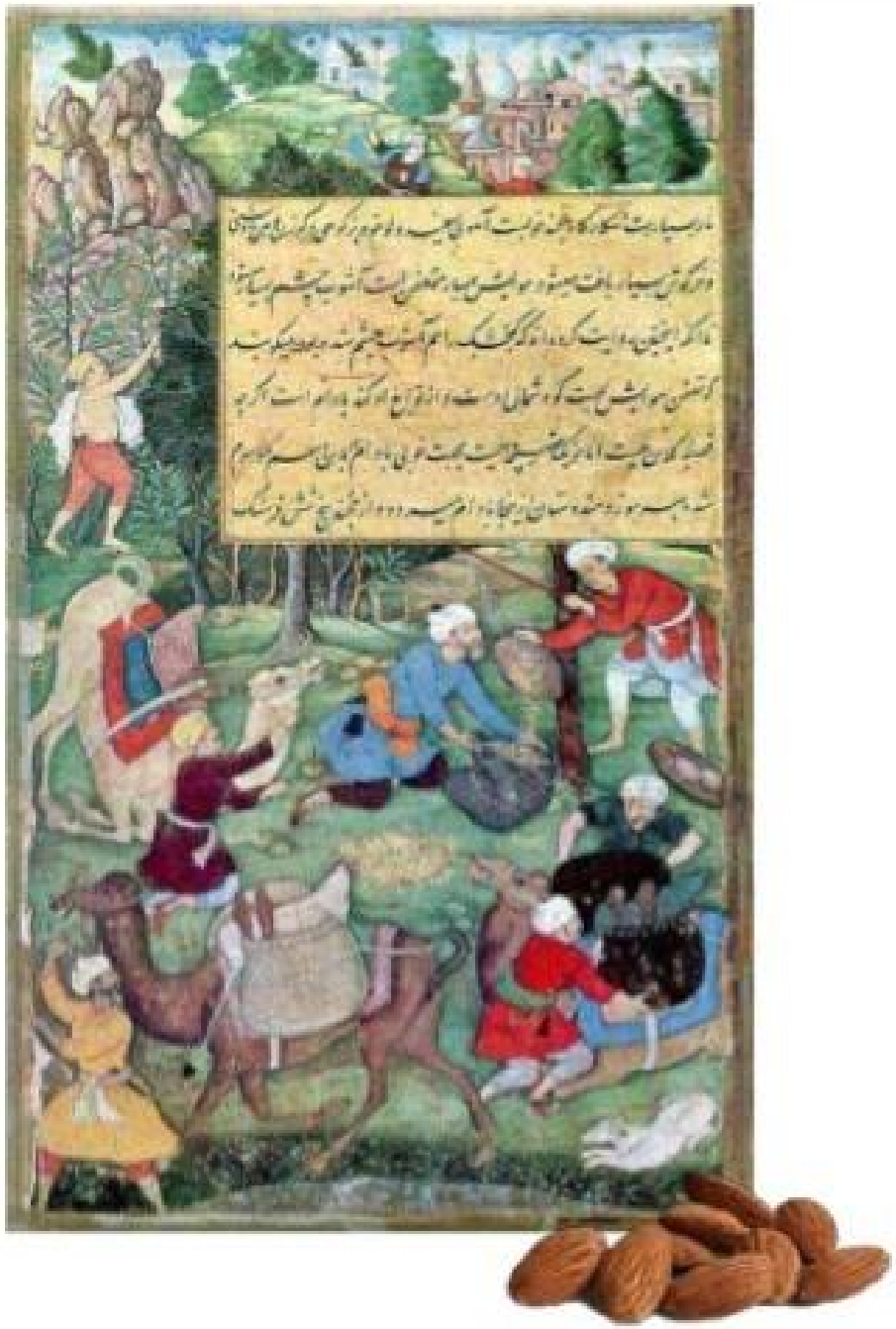
• sub tropical varieties of almond is grown in North Indian conditions.

Almond History

- Prehistory
  - Wild almonds emerge on mountains separating China from Kazakhstan, Afghanistan and Iran
- 4,000 B.C.
  - Almonds cultivated in Central Asia and eastern Mediterranean
- 1,352 B.C.
  - King Tut takes handful of almonds to his grave
- 350 B.C.
  - Alexander the Great's armies bring almonds to Greece

Almond History

- 1500's
  - Harvest in the Fergana Valley Uzbekistan



Almond History

- 1700's
  - Brought to California from Spain by Franciscans
- 1840's
  - California growers experiment with almonds
- 1880's
  - California almond crop tops one million Lbs.
- 1986
  - "A Can A Week Is All We Ask" ad begins
- 2002
  - California almond crop tops one billion Lbs.
- 2014 +
  - California crop expected to top two billion Lbs.

Almond History

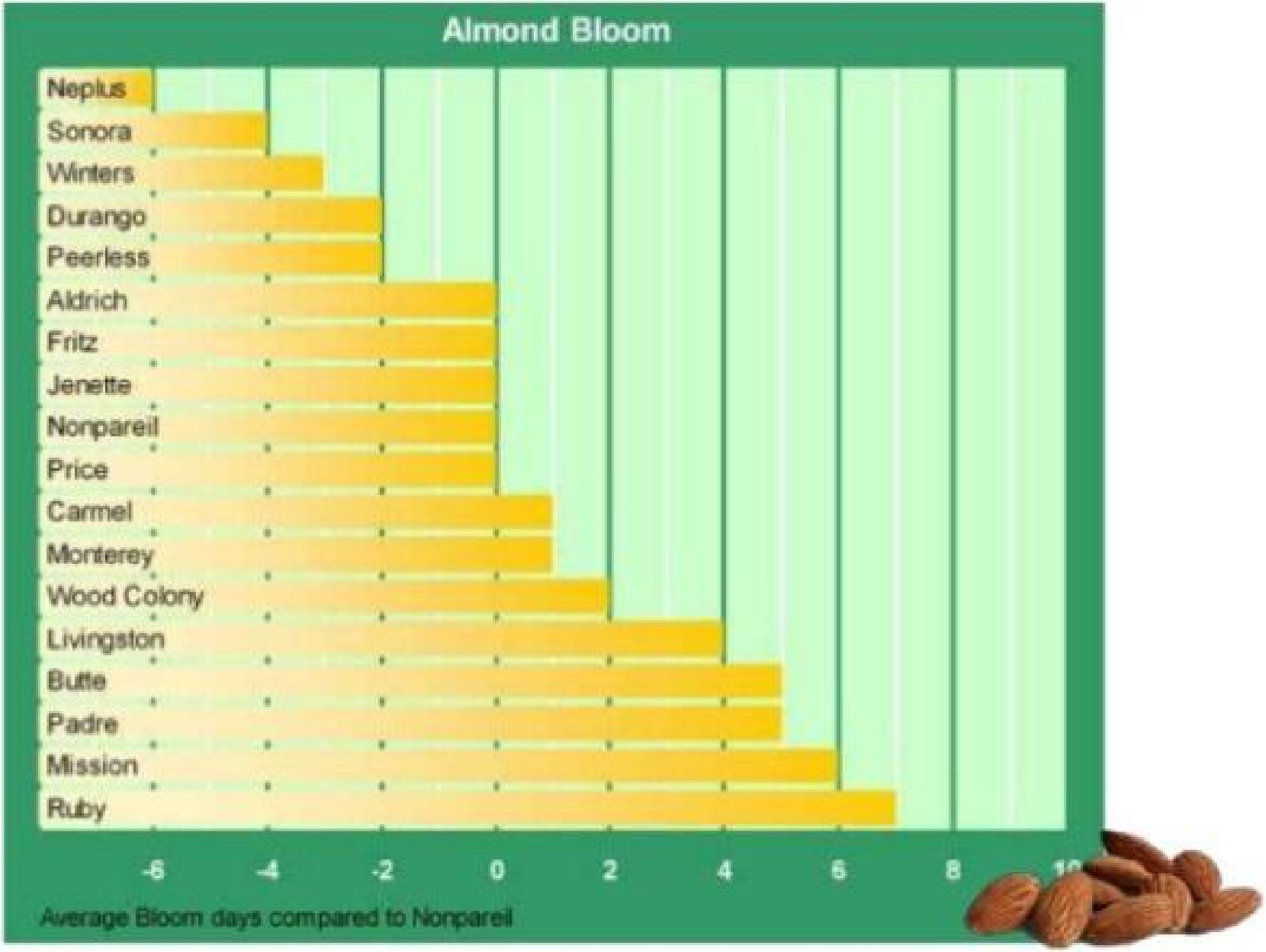
Blossoming Almond Tree - Vincent Van Gogh (1890)

Blossoming Almond Tree – iPhone Case (2013)

Almond Lifecycle

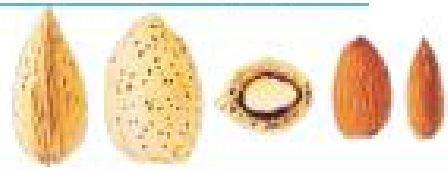
Production Items

Almond Varieties

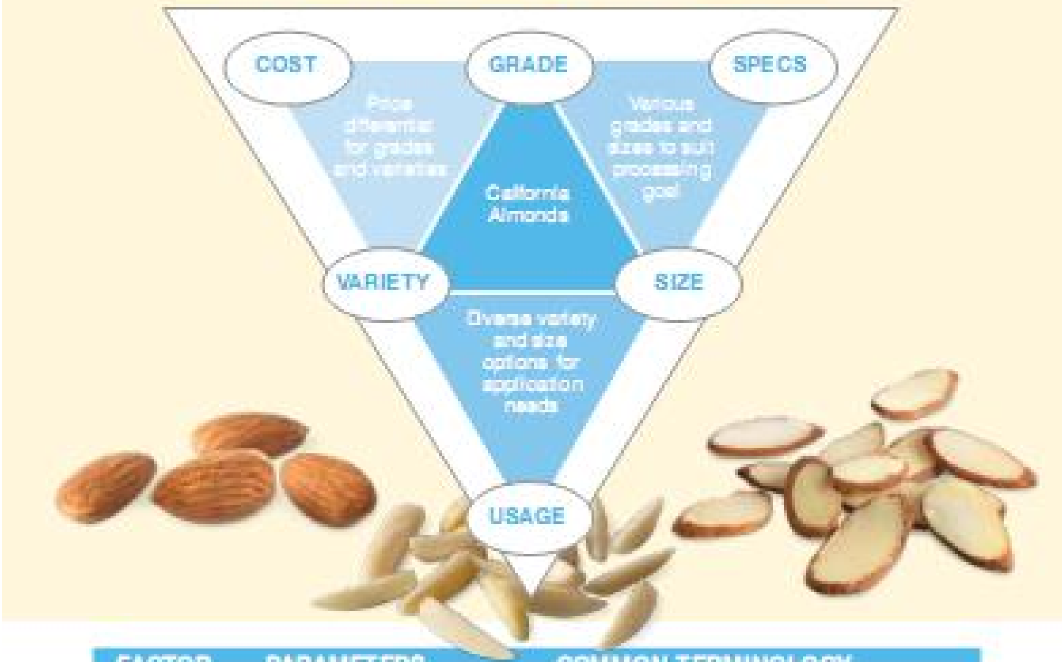


MAJOR CALIFORNIA ALMOND VARIETIES

variety		CHARACTERISTICS: LONG & FLAT	CHARACTERISTICS: SHORT & PLUMP/ROUND	CLASSIFICATION: CALIFORNIA TYPE	CLASSIFICATION: MISSION TYPE	CLASSIFICATION: NONPAREIL	CLASSIFICATION: M-SHELL HARD SHELL
NONPAREIL (NP)	 SHELL Soft shell, light color, high suture opening NUT Medium, flat shape, smooth surface	●				●	
CARMEL (CR)	 SHELL Soft shell, good shell integrity, flat suture opening NUT Medium, narrow shape, slightly wrinkled surface	●		●			
BUTTE (BT)	 SHELL Semi-hard shell, light color, smooth surface, low suture opening NUT Small, short plump shape, wrinkled surface		●	●	●		
PADRE (PD)	 SHELL Hard shell, good shell integrity, no suture opening NUT Small, short wide shape, wrinkled surface		●	●	●		
MISSION (MI)	 SHELL Hard shell, good shell integrity, no suture opening NUT Small, short wide shape, dark brown, deeply		●		●		

		CHARACTERISTICS		CLASSIFICATION			
		LONG & FLAT	SHORT & PLUMP/ROUND	CALIFORNIA TYPE	MISSION TYPE	NONPAREIL	BI-STATE HARD SHELL
MONTEREY (MT) 	**SHELL** Hard shell, smooth surface, low suture opening **NUT** Large, long narrow shape, deeply wrinkled surface	●		●			
SONORA (SN) 	**SHELL** Soft shell, dark brown color/rough surface, high suture opening **NUT** Large, long narrow shape, light color, smooth surface	●		●			
FRITZ (FR) 	**SHELL** Semi-hard shell, good shell integrity, low suture opening **NUT** Small /medium plump shape, fairly wrinkled surface		●	●	●		
PRICE (PR) 	**SHELL** Soft shell, dark brown color/rough surface, high suture opening **NUT** Small, short narrow shape, fairly wrinkled surface	●		●			
PEERLESS (PL) 	**SHELL** Hard shell, good shell integrity, smooth surface, no suture opening **NUT** Medium, wide shape, fairly wrinkled surface	●		●			●

almond purchasing considerations

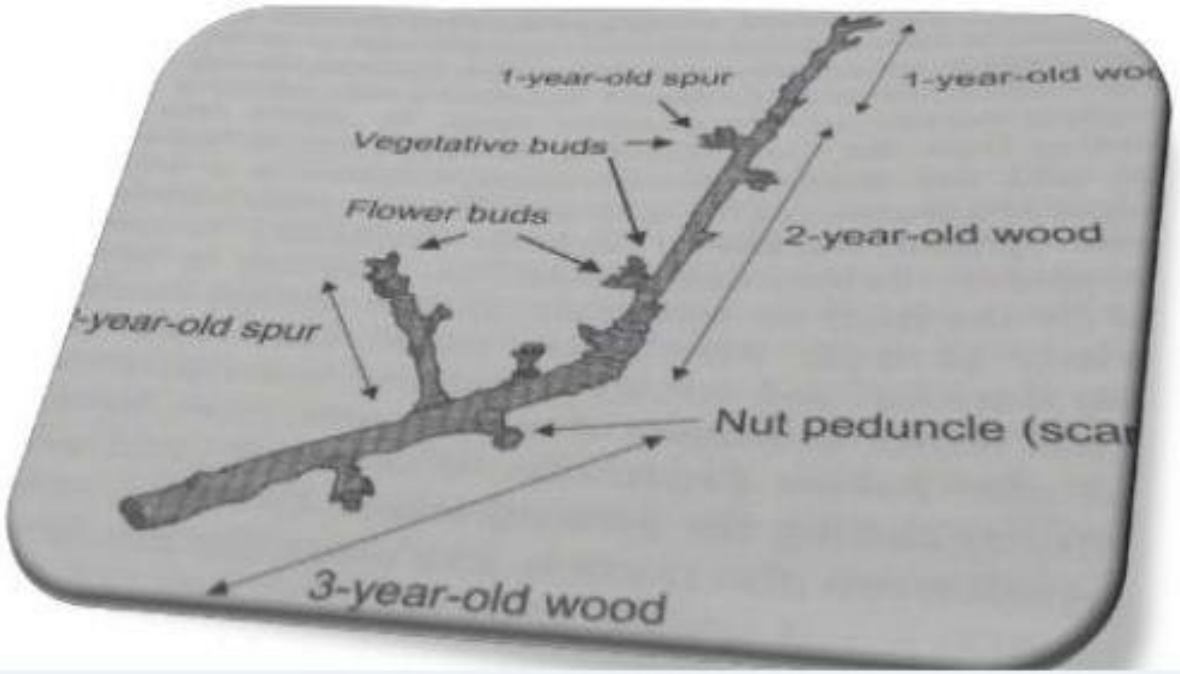


FACTOR	PARAMETERS	COMMON TERMINOLOGY
VARIETY	Shape, color, skin texture or smoothness, blanchability	Nonpareil, Carmel, Butte, Padre, Mission, Monterey, Sonora, Fritz, Peerless, Price
SIZE*	Count range of whole almond kernels per ounce (28.35 grams)	18/20, 20/22, 23/25, 25/27, 27/30, 30/32, 32/34, 34/36, 36/40, or customer-specified range
GRADE	Dissimilars/doubles, chipped and scratched kernels, foreign material, split and broken kernels, other defects and serious damage	Fancy, Extra No. 1, No. 1 (Supreme), Select Sheller Run, Standard Sheller Run, No. 1 Whole and Broken, No. 1 Pieces
IN-SHELL	Shell hardness, shell integrity, suture opening, kernel quality, crack out	Market specific, depending on how in-shell will be ultimately sold to consumers, for example: Traditional: sold in the shell—semi- or hard shell acceptable, cracked with a mechanical nut cracker Snack: sold in the shell—soft shell with greater suture opening to allow seasonings to permeate the shell Hand Crack: sold as kernels—soft shell preferred to allow manual cracking

*[illegible]

BOTANY

- Botanically Almond is a Drupe
- Edible part is nut
- Inflorescence come laterally on current season growth which bear fruit in following season.



Sometimes flower bud comes both terminally and laterally which is advantageous. Shoot bearing promotes PRECOCIOUS bearing while spur bearing increase bearing surface.

CONTD.....

- Almond produces peryginous self-incompatible flowers.
- It is cross pollinated mainly by Honey bee
- Flower differentiation takes place during summer and floral development continues into autum to winter.
- Flowering is determined by the chilling and subsequent heat requirement.
- Bloosm opening in almond is a typical sigmoid response curve.

INFLORESCENCE OF TEMPERATE ALMOND

INFLORESCENCE OF SUB-TROPICAL ALMOND

Bud Break / Bloom

- February and March

Bloom

Bloom Sprays

Pollination

- Single most important yield factor
  - Hive management critical
  - 2 Hives per Acre at bloom
  - $150 -$200/Hive
- Colony Collapse Disorder
  - Varroa mites
  - Neonicotinoids
  - Habitat loss
  - Virus
  - American foulbrood disease

Pollination

Maturing Nuts

- April - June

Hull Split

- July - August

Harvest

- August - October

- Shaking
- Raking / Sweeping – Dry on orchard floor
- Pickup
- Hulling / Shelling
- Processing

Harvesting:

HARVESTING TIME: Early August to Late September

HARVESTING INDICES:

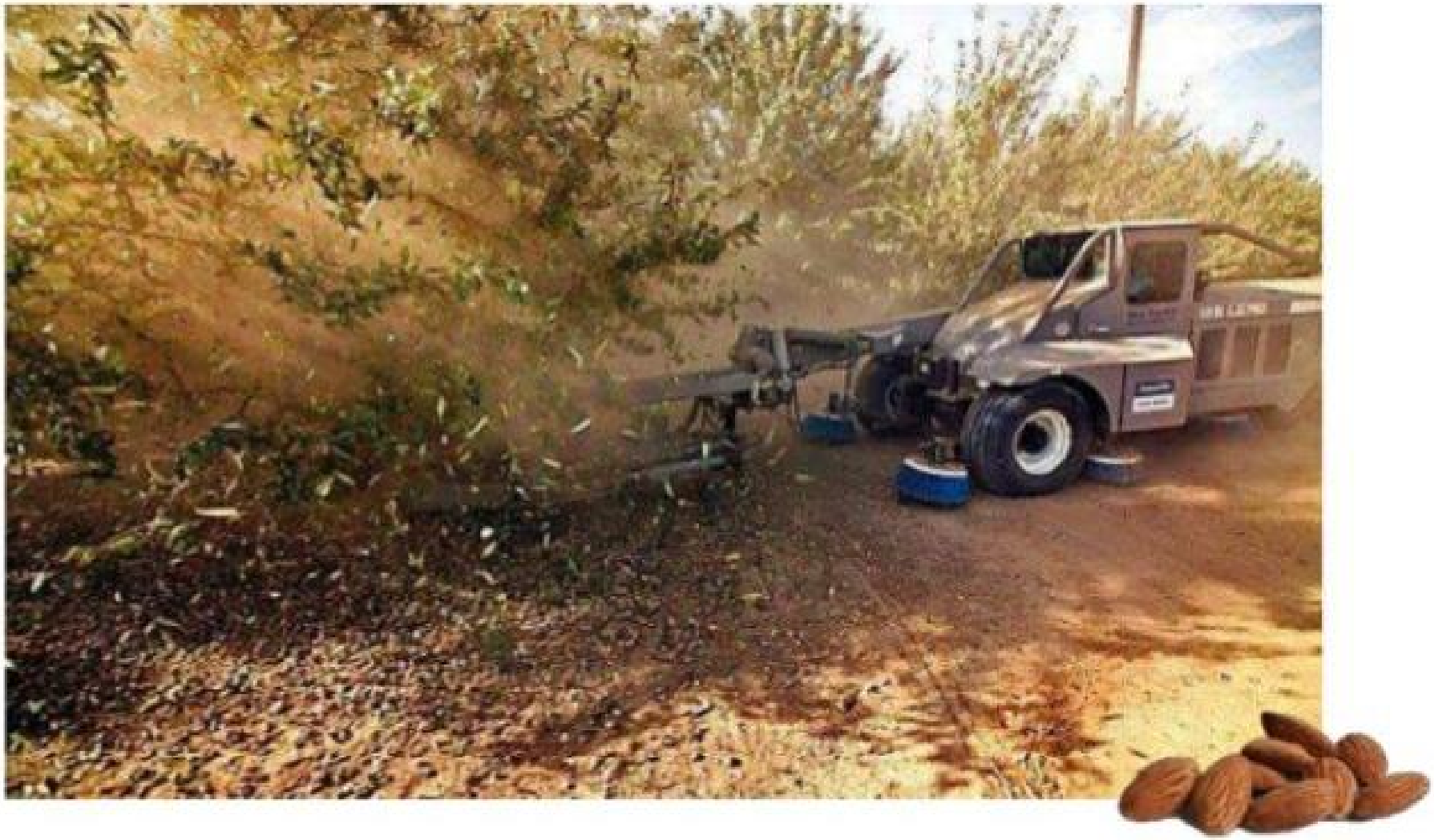
- Hull split of 95% of nuts
- Ripened nuts should be prevented from bird damage

HARVESTING METHOD:

Almond tress are knocked and falling nuts are collected in net

Almond Harvest

- **Shaking**



Harvest

- **Raking / Sweeping**

Harvest

- Hulling

HULLING AND DRYING:

HULLING

DRYING

- Hulling is the method of removal of hull which can be done manually or mechanically
- To prevant mould growth during storage drying is done under sun bye spreading almonds in thin layer till they make brittle sound.

Harvest

- **Hulling**

Processing - Products

INFLORESCENCE OF TEMPERATE ALMOND

INFLORESCENCE OF SUB-TROPICAL ALMOND

CONTD……

- Fruit Growth occur in three stages
- STAGE 1: Pericarp, seed, nucellus develops
- STAGE 2: Endosperm and embryo enlrage
- STAGE 3: Dry weight of embryo increases
- Physiological process which accompanies fruit ripening includes :
- dehiscence of hull or mesocarp
- Hull split
- Fruit abscission
- Dehydration

STORAGE:

- Before going for storage nuts should be treated at -17.8 *c for 48 hours to destroy the eggs and pest of previously applied naval orange pest
- Almond can be stored for * months under room temperature
- It can also be stored for more years if kept at 0 to 7 *C

Water Management

- Central Valley is a Mediterranean Climate
  - Cool, wet winters and warm, dry summers
- Limited Water Supplies
  - Drought conditions
  - Regulatory issues
- Use roughly 3.5 – 4.0 Acre Feet / Acre
  - Drip irrigation is method of choice
  - Soil amendments, fertilizers through drip

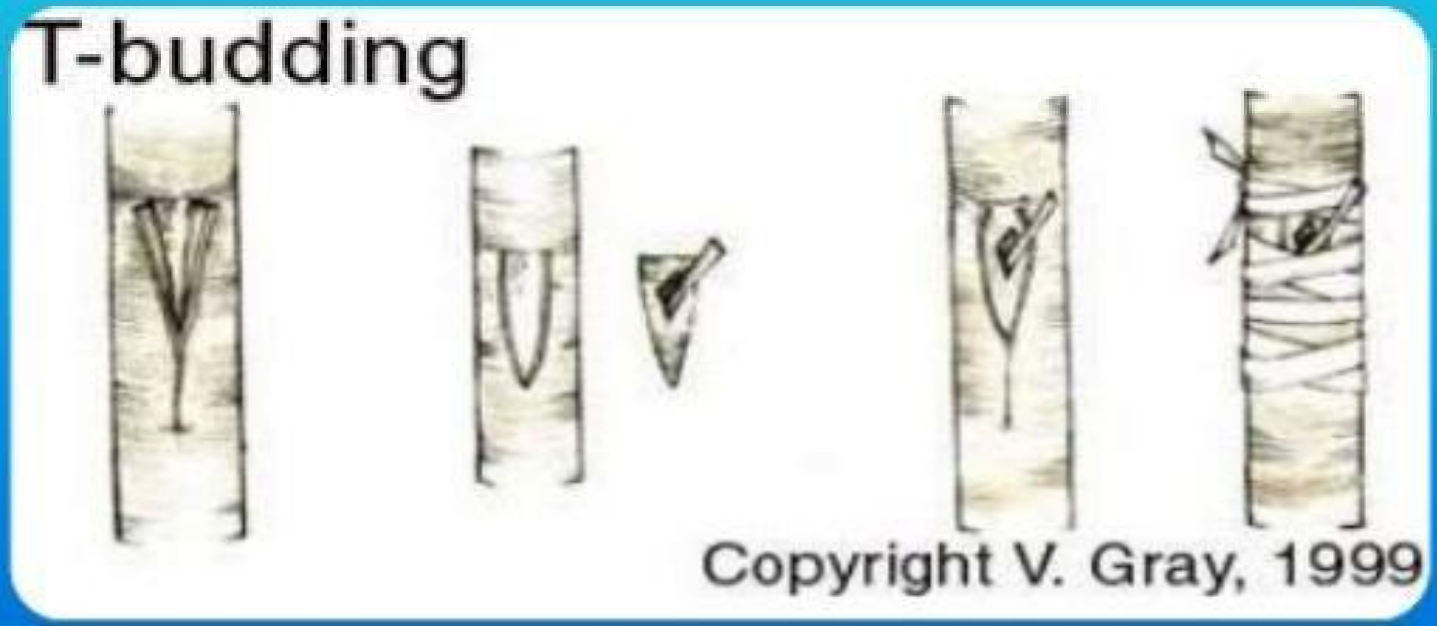
Irrigation

- Methods of Irrigation
  - Flood
  - Drip
  - Micro

PROPAGATION:

TIME: **Late spring, root stock grown in autum**

METHOD: **T-Budding**



RAISING OF ROOT STOCK:

- Peach, Plum or almond x Peach hybrids are taken as rootstocks
- Fruits are collected at hull spilt stage
- Seed extraction is done
- Seed soaking
- Stratification
- Sowing
- fungicide treatment

Cultivation

Planting

- Almond plants are planted in **1m x 1mx 1m** sized pits at a distance of **4.5 m x 4.5m** in January in square system.
- Most of the almond varieties are **self-unfruitful**. Therefore to plant **two or more cross-compatible varieties** which flower at the same time in alternate rows are essential.

Training and pruning

- Almond plants are trained according to **modified leader system**.
- It bears mostly on spurs which live for five years. Thus in young trees, only diseased, dry wood and the branches which are interfering with each other should be removed.
- Water sprouts arising on the stem should also be removed as early as possible.
- In old bearing trees, pruning is done to remove one-fifth of the growth every year.

FERTILIZATION AND IRRIGATION:

- As mesophytic origin crop it required less water.
- Irrigation should be done thoroughly but not so frquently as it is suseptible to water logging conditon
- Irrigation should be with holded prior to harvest as the result ing water stress promotes abscission layer
- It mainly required Nitrogen application.
- Almond removes 45kg of actual N from soil
- Leaf analysis should be done during summer to identify deficiencies
- Under high yield cropping systems pottasium and zinc may be applied as potassium easilyfixed by clay become unavailable for root uptake
- Zinc or foliar spray of zinc sulphite in autumn helps to remove remaining leaves on tree as they go into winter dormancy