



WELCOME

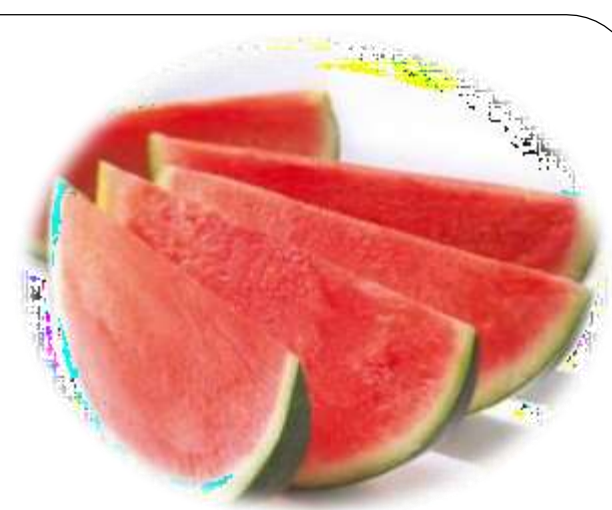
Parthenocarpy in vegetable crops



Outline

- **Parthenocarpy**
- **Importance**
- **Mechanism of parthenocarpy**
- **Different approaches**
 - ✓ **Tomato**
 - ✓ **Cucumber**
 - ✓ **Brinjal**
 - ✓ **Capsicum**
 - ✓ **Watermelon**
- **Conclusion**
- **Future thrust**

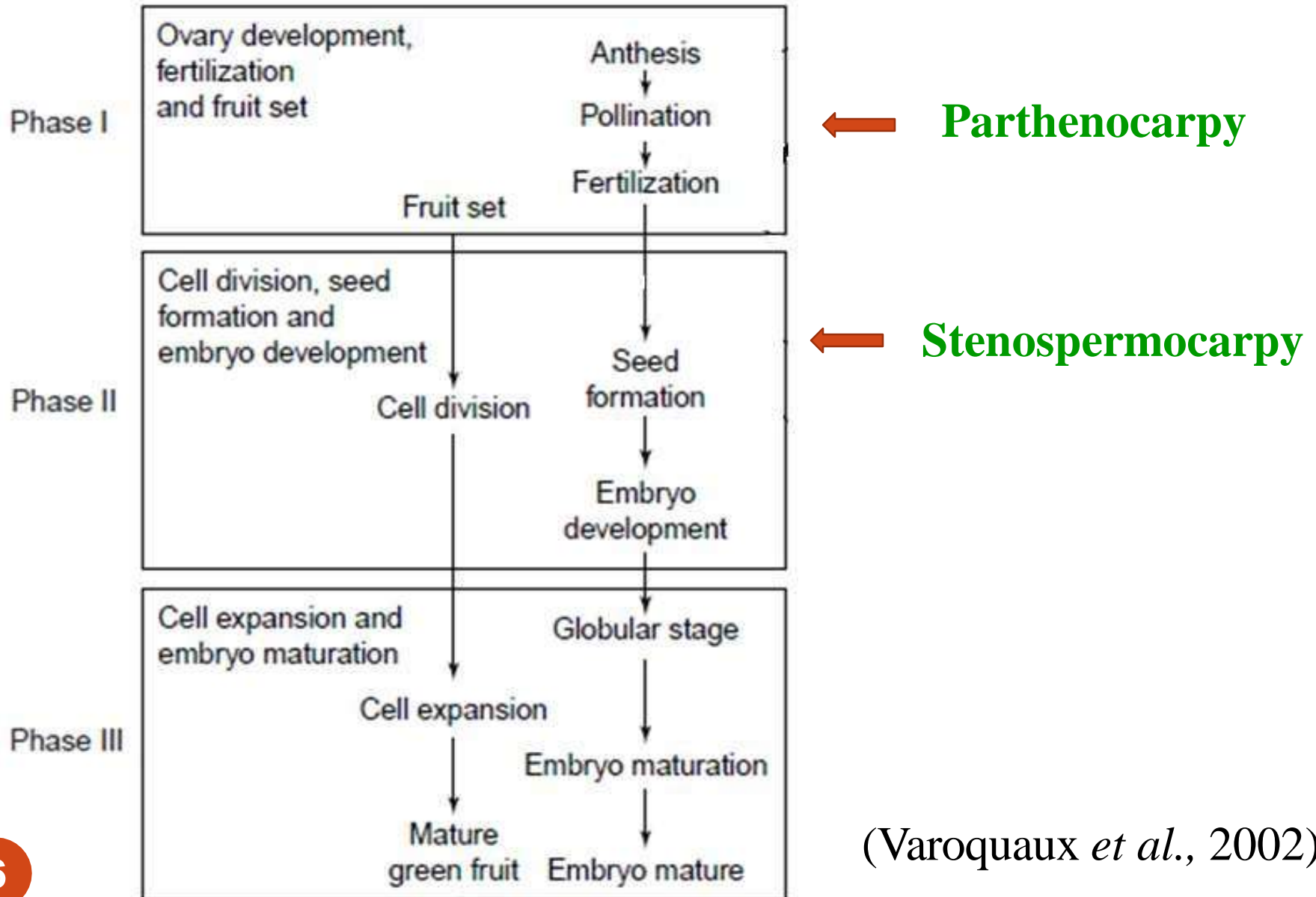
Parthenocarpy



- *Parthenos*, virgin; *karpos*, fruit
- Introduced - Noll, 1902
- Natural or artificially induced fruit development without pollination and fertilization
- Seedless

(Gustafson, 1942)

Fruit developmental phases



(Varoquaux *et al.*, 2002)

Types of parthenocarpy

1. Genetic /natural parthenocarpy

❖ **Obligatory** : no external influence

Eg : Banana, pineapple and ivy gourd

❖ **Facultative** : adverse conditions for pollination and fertilization

Eg : Tomato, brinjal and cucumber

(Gustafson, 1942)

2. Artificially induced parthenocarpy

- ❖ Irradiated pollen
- ❖ Synthetic auxin
- ❖ Gibberellins

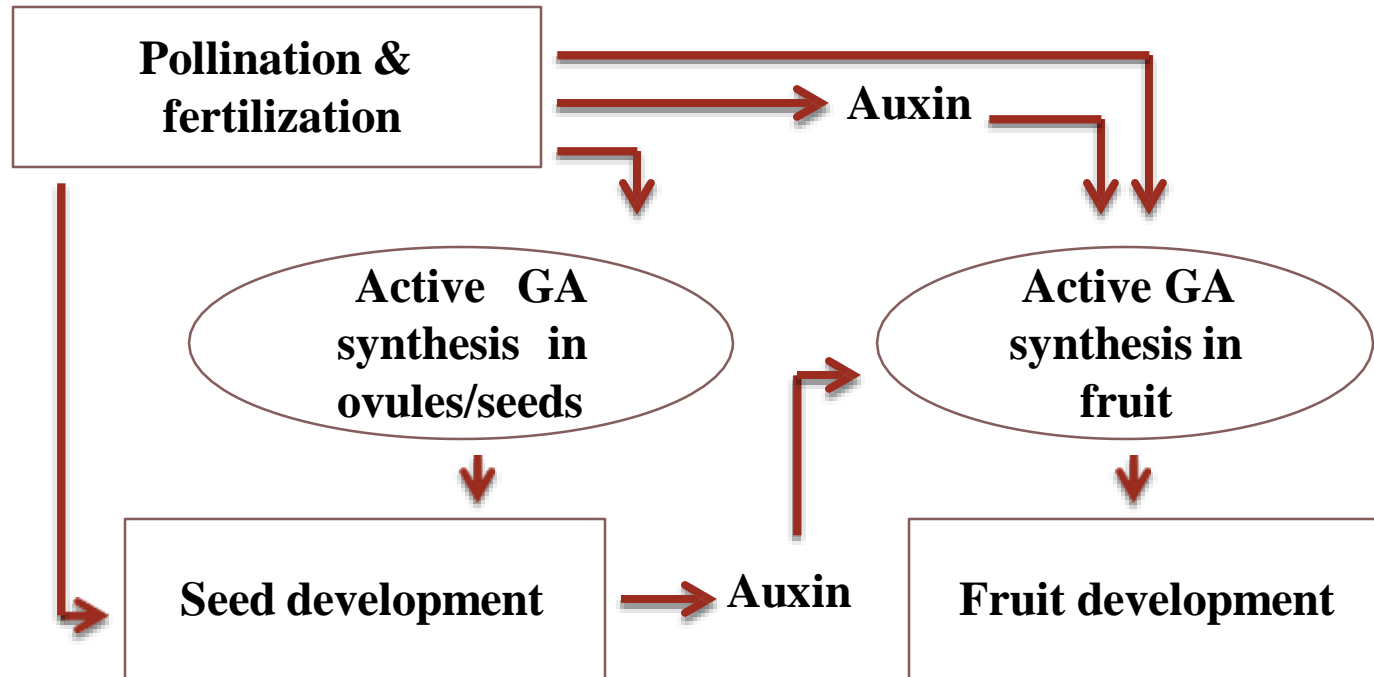
(Gustafson, 1942)

Importance of parthenocarpy in vegetable crops

- ❖ Increased production under adverse environment
- ❖ Seedless fruits
- ❖ Improved quality
- ❖ Off season production
- ❖ Protected cultivation
- ❖ Reduced cost of cultivation

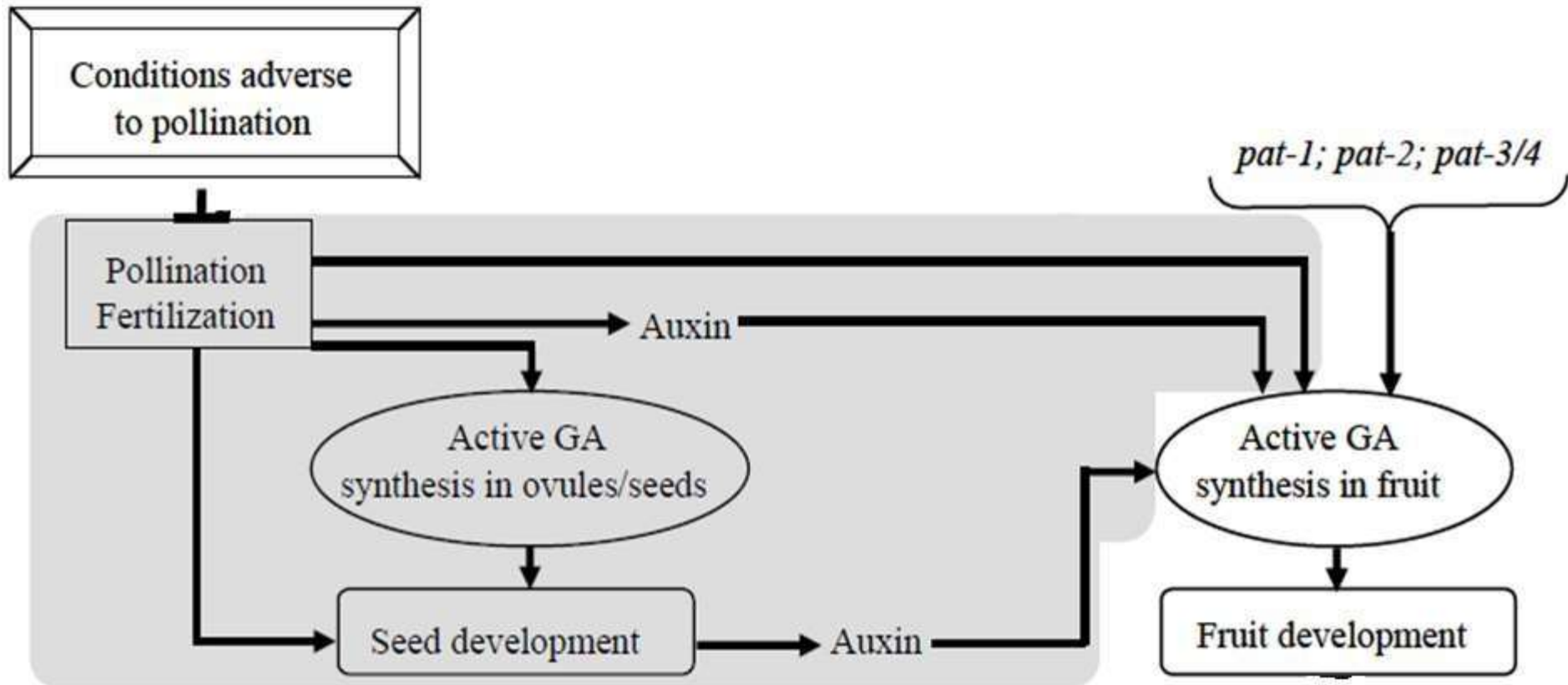
(Varoquaux *et al.*, 2002)

Mechanism of parthenocarpy



(Gorguet *et al.*, 2005)

Mechanism of parthenocarpy



(Gorguet *et al.*, 2005)

Approaches

❖ **Breeding approaches**

✓ **Conventional** : Inter specific hybridization
: Intra specific hybridization

✓ **Mutation**

✓ **Polyploidy**

❖ **External application of PGR**

❖ **Transgenic approach**

(Varoquaux *et al.*, 2002)

PGR induced parthenocarpy

Crop	PGR	Concentration	Reference
Brinjal	2,4-D	200 ppm	Muthukrishnan and Srinivasan, 1980
Spine gourd	NAA	100 ppm	Singh, 1970
Sweet gourd	NAA	100 ppm	Vijay and Jalikep, 1980
Cucumber	GA	100 ppm	Choudury and Phatak, 1960

Genetic engineering for parthenocarpy

- ❖ Unbalanced embryo development and/or prevention of seed development
- ❖ Affecting phytohormone content and/or activity in the desired organ

(Rotino *et al.*, 1997)

DefH9- iaaM chimeric gene

- ❖ *iaaM*- auxin synthesising gene- *Pseudomonas syringae* pv. *savastanoi*
 - ✓ Indolacetamide monooxygenase
- ❖ *DefH9*- ovule/placenta specific promoter- *Antirrhinum majus*
- ❖ Tomato, eggplant and cucumber

(Rotino *et al.*, 1997)



Tomato



Tomato (*Solanum lycopersicum*)

- ❖ Three sources - facultative parthenocarpy
- ❖ Montfavet-191 (*Pat-1*)
- ❖ Severianin (*Pat-2*)
- ❖ RP75/59 (*Pat-3/Pat-4*)



(Gorguet *et al.*, 2005)

Pat-1

- ❖ Montfavet-191
- ❖ Abnormal stamens
- ❖ Higher ovary and pericarp growth
- ❖ Female sterility
- ❖ Defective pollen tube- placenta interaction
- ❖ Low seed set

(Gorguet *et al.*, 2005)

Pat-2

- ❖ Single recessive gene
- ❖ Genetic background of the recurrent parent is very important for vigour

(Philouze *et al.*, 1988)

- ❖ Parthenocarpic plants have determinate growth habit

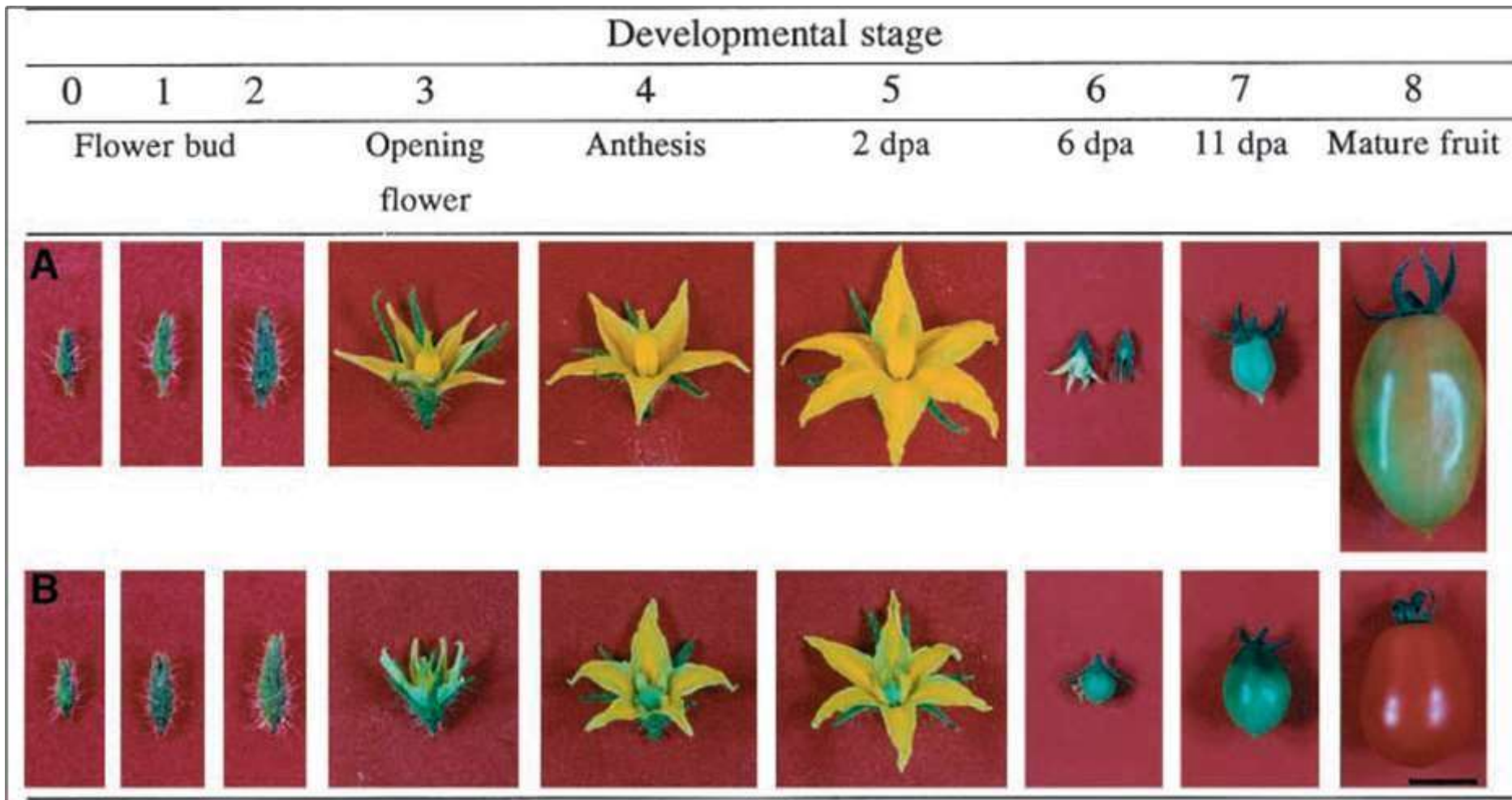
(Lin *et al.*, 1984)

Pat-3/Pat-4

- ❖ RP75/59 progeny of Atom x Budjekosoko
- ❖ Seeded fruits suppress the size of seedless fruits
- ❖ Digenic inheritance

(Gorguet *et al.*, 2005)

Developmental stages of tomato flowers and fruits

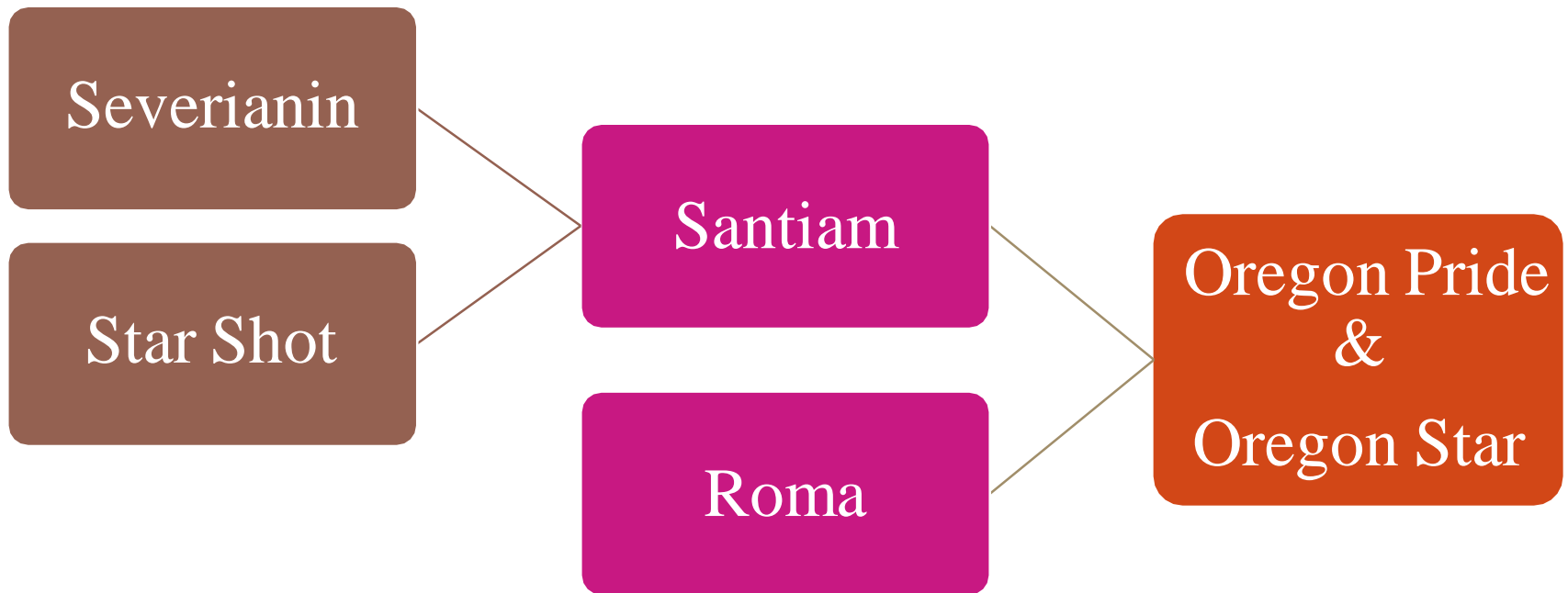


(A) Normal-type

(B) *Pat* plants

(Andrea *et al.*, 2006)

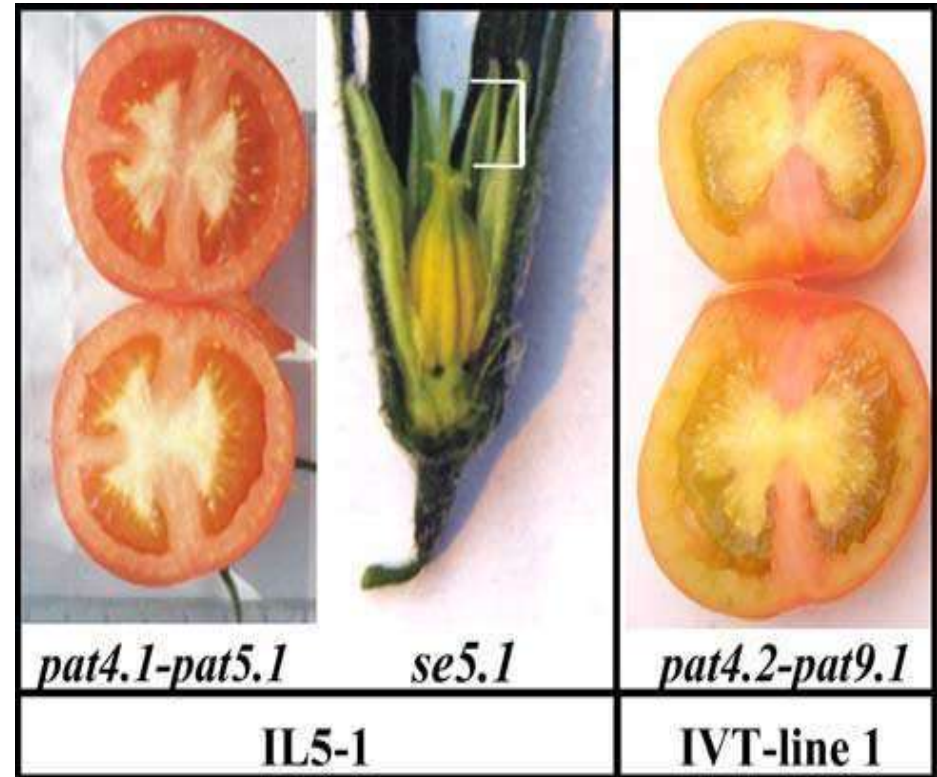
Development of parthenocarpic tomato varieties



(Baggett *et al.*, 1995)

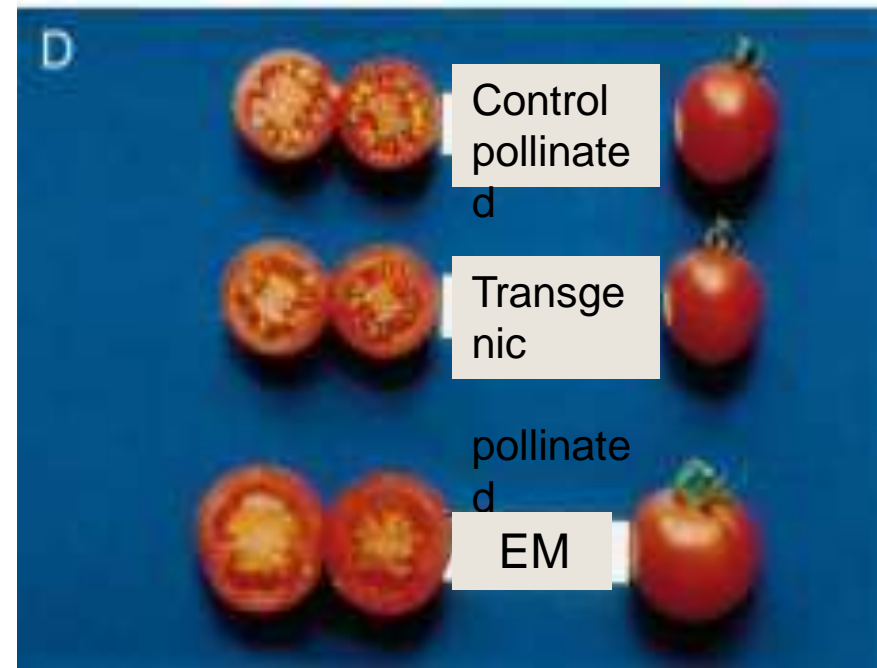
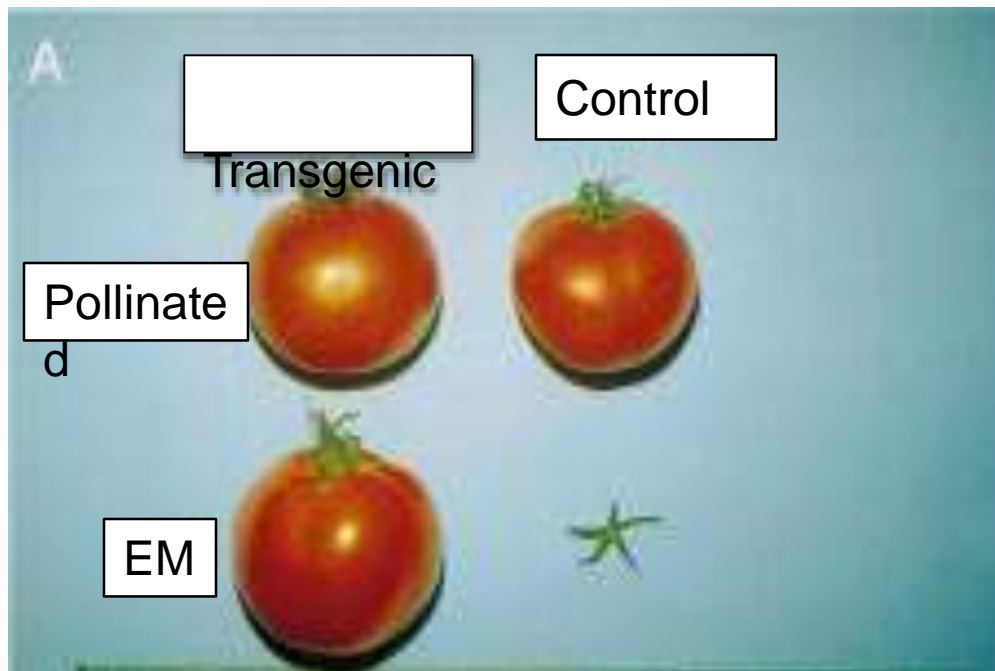
Mapping of novel parthenocarpy QTLs in tomato

- **Two QTLs in IL5-1**
 - pat4.1
 - pat5.1
- **IVT-line1 contains two QTLs**
 - pat4.2
 - pat9.1

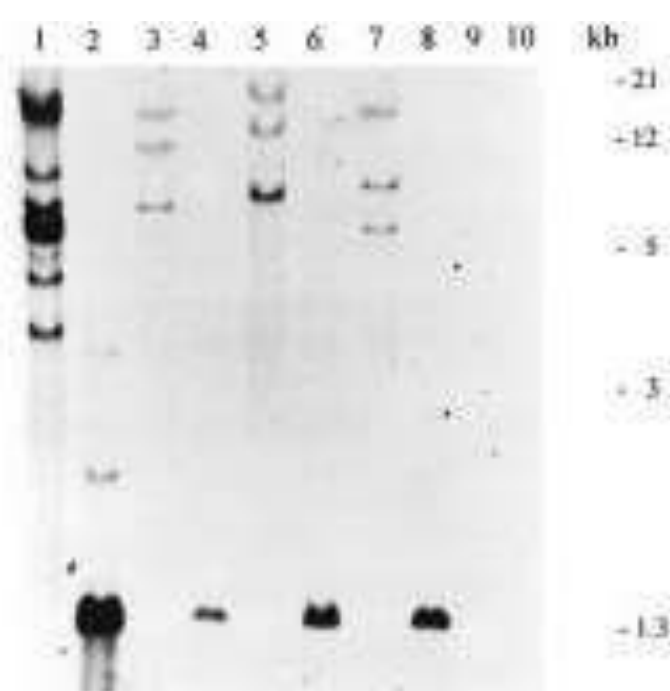


Transgenic parthenocarpic tomato

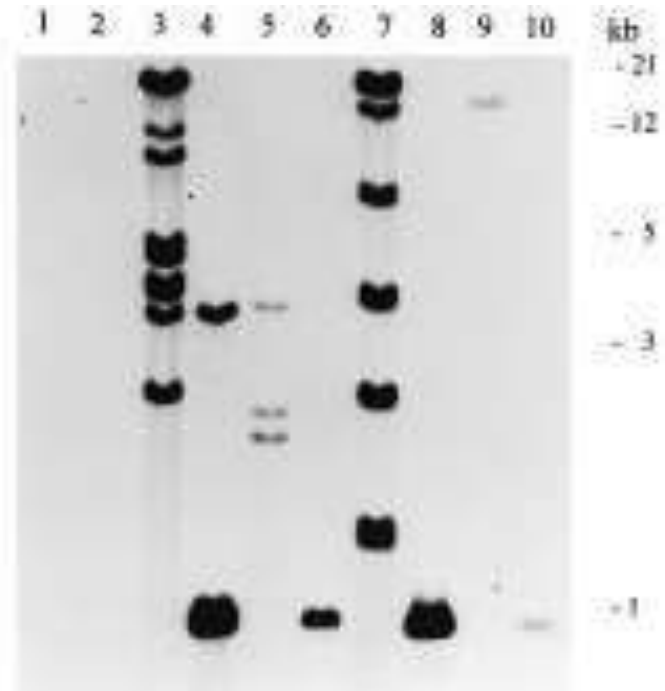
- *DefH9-iaaM*
- CM and L 276



Southern blot analysis



CM control : lane 9 & 10
CM 11 :lane 1 & 2
CM 12 :lane 3 & 4
CM 13 :lane 5 & 6
CM 14 :lane 7 & 8

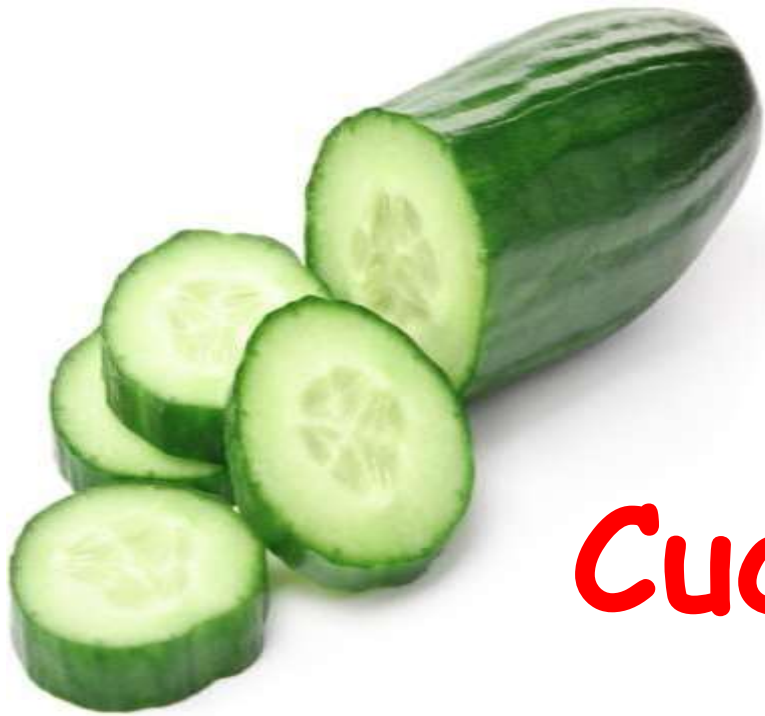


L.276 control : lane 1 & 2
L.276-1 :lane 3 & 4
L.276-4 :lane 5 & 6
L.276-6 :lane 7 & 8
L.276 -7:lane 9 & 10

(Ficcadenti *et al.*, 1999)

Parthenocarpic potentiality of transgenic tomato lines

Lines	Fruit set/ emasculated flowers	Fruit set (%)	Av. fruit weight (g)	
			Selfed	Emasculated
CM 11	16/16	100.0	22.28	22.35
CM 12	26/32	81.3	14.57	18.35
CM 13	15/24	62.5	16.50	18.90
CM 14	13/14	92.9	12.96	13.96
CM Control	0/32	0.00	15.99	—
L.276 1-1	22/22	100.0	120.76	121.65
L.276 4-1	13/13	100.0	95.16	131.00
L.276 6-1	14/14	100.0	126.62	134.55
L.276 7-1	12/12	100.0	88.45	88.65
L.276 Control	0/23	0.00	95.24	—



Cucumber

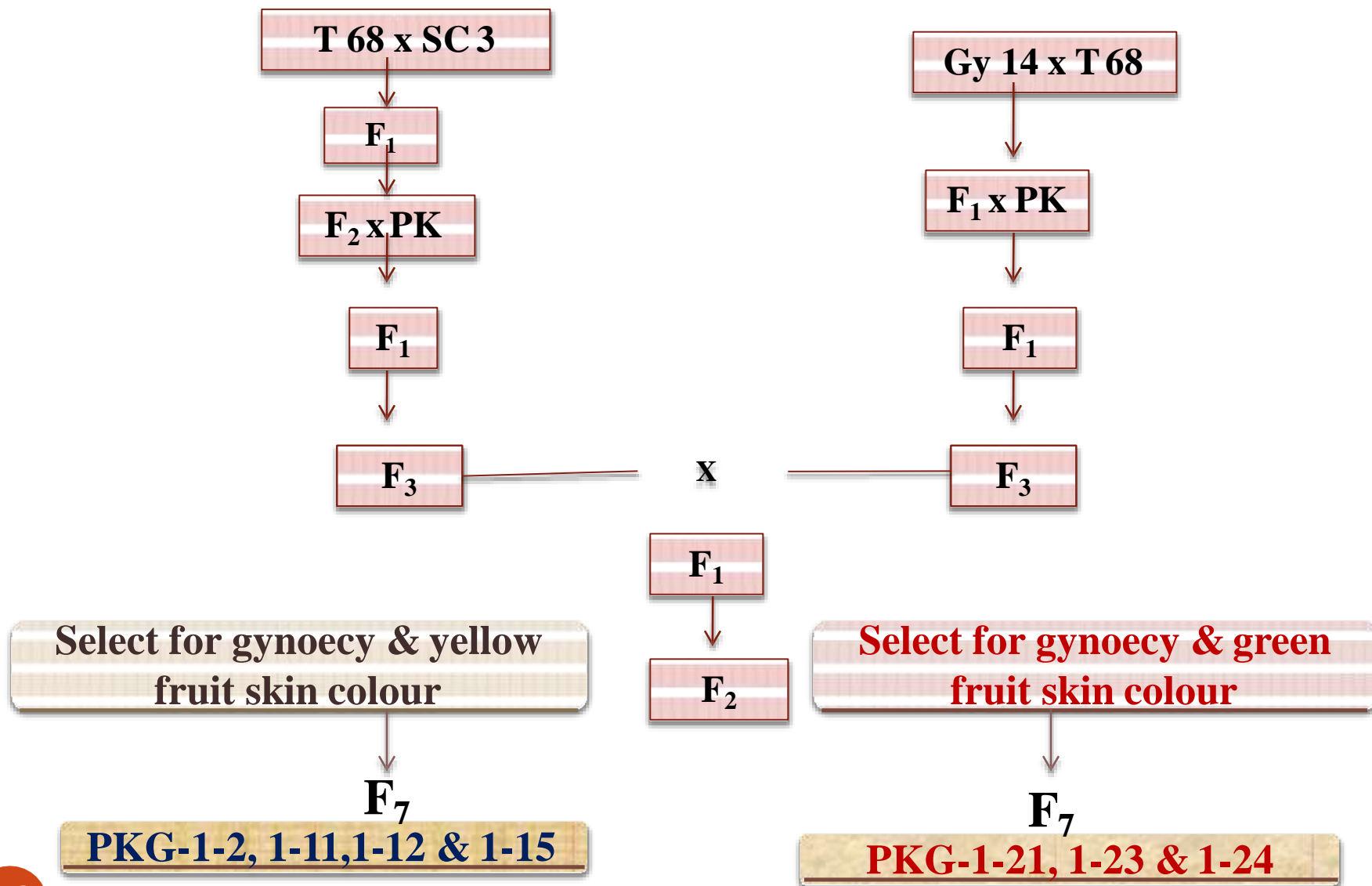


Genetics of parthenocarpy in cucumber

- Incomplete dominant gene P
- PP produces parthenocarpic fruits early
- Pp produce parthenocarpic fruits later than homozygous plants
- pp produces no parthenocarpic fruits

(Pike and Peterson, 1969)

Development of parthenocarpic tropical gynoecious lines in cucumber



(More and Budgular, 2002)

Isolation of parthenocarpic tropical gynoecious cucumber lines

PKG lines	Fruit set (%)	No. of parthenocarpic fruits	Parthenocarpy (%)
Yellow types			
PKG-1-1	68.4	24	92.3
PKG-1-2	73.9	17	100.0
PKG-1-3	64.9	21	87.5
PKG-1-4	63.4	23	88.5
PKG-1-5	56.1	22	95.7
PKG-1-6	65.8	24	96.0
PKG-1-7	63.6	27	96.4
PKG-1-8	73.8	29	93.5
PKG-1-9	75.0	17	94.4

(More and Budgajar, 2002)

Contd...

	Fruit set (%)	No. of parthenocarpic fruits	Parthenocarpy (%)
PKG-1-11	62.5	20	100.0
PKG-1-12	64.7	22	100.0
PKG-1-14	38.2	12	92.3
PKG-1-15	80.0	16	100.0
Green types			
PKG-1-21	56.8	21	100.0
PKG-1-22	50.0	18	94.7
PKG-1-23	64.0	16	100.0
PKG-1-24	55.9	19	100.0
PKG-1-25	61.3	18	94.7
PKG-1-26	44.2	19	82.7

Parthenocarpic cucumber varieties/lines from public sector

Sl. No	Name of the variety/line	Source
1	Pant Parthenocarpic Cucumber-2	GBPUAT, Pant Nagar
2	Pant Parthenocarpic Cucumber-3	GBPUAT, Pant Nagar
3	DPaC-6	IARI, New Delhi
4	DPaC-9	IARI, New Delhi
5	DPaC-10	IARI, New Delhi

Parthenocarpic cucumber varieties



**Pant Parthenocarpic
Cucumber-2**



**Pant Parthenocarpic
Cucumber-3**

Parthenocarpic cucumber hybrids from private sector

Sl. No	Name of the hybrid	Source of seed
1	Isatis	Nunhems India Pvt. Ltd
2	Hilton	Nickerson Zwaan
3	PY-1026	East West Seeds India Pvt. Ltd
4	NS-492	Namdhari Seeds India Pvt. Ltd
5	NS-498	Namdhari Seeds India Pvt. Ltd
6	NS-499	Namdhari Seeds India Pvt. Ltd
7	Claudia	Tropic Seeds Pvt. Ltd
8	Aviva	Tropic Seeds Pvt. Ltd
9	Asma	Tropic Seeds Pvt. Ltd
10	Kian	Nunhems India Pvt. Ltd



Isatis



Kian



Hilton



NS- 492



NS- 498



Aviva

Work at KAU



Maintenance of parthenocarpic gynoecious lines

- ❖ Silver nitrate (AgNO_3) - Male flowers in gynoecious cucumbers
- ❖ AgNO_3 at 400 and 500 ppm
- ❖ Two –three true leaf stage
- ❖ Two or three times spray - Effective

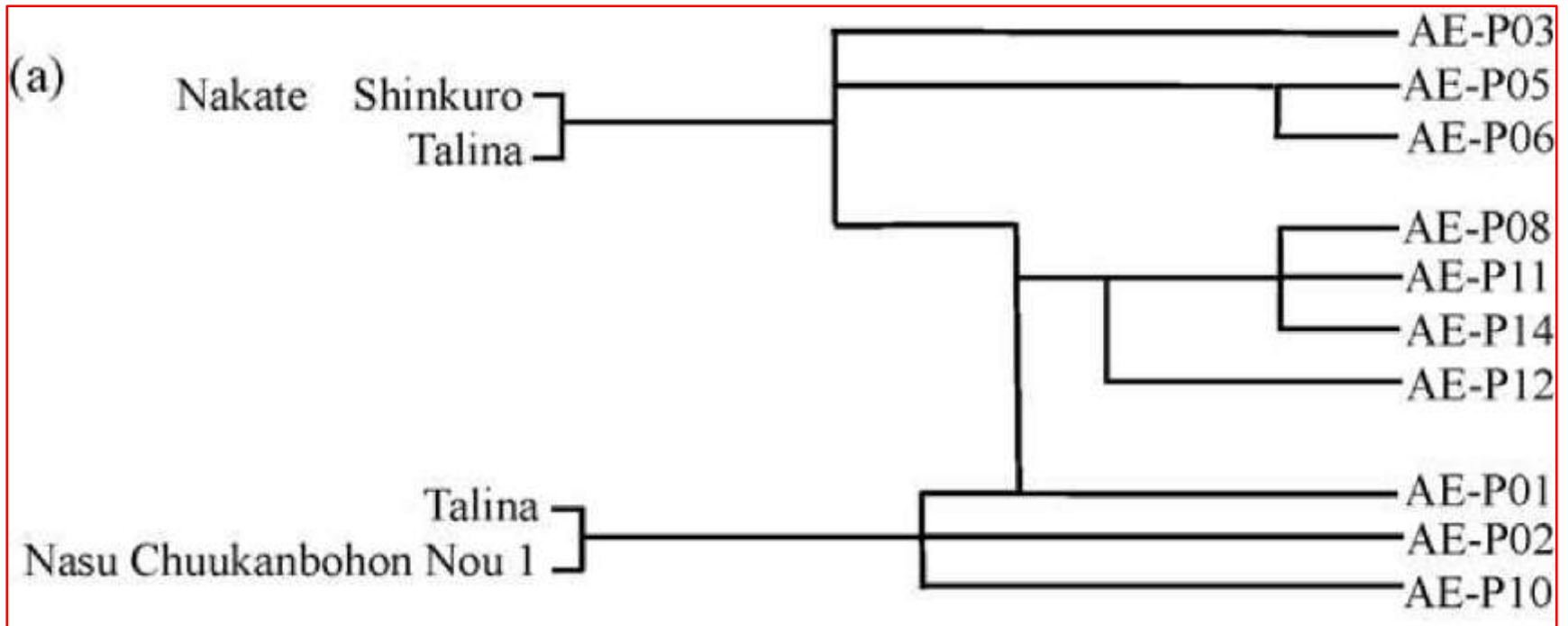
(Elizabetha and Susaj, 2010)



Brinjal

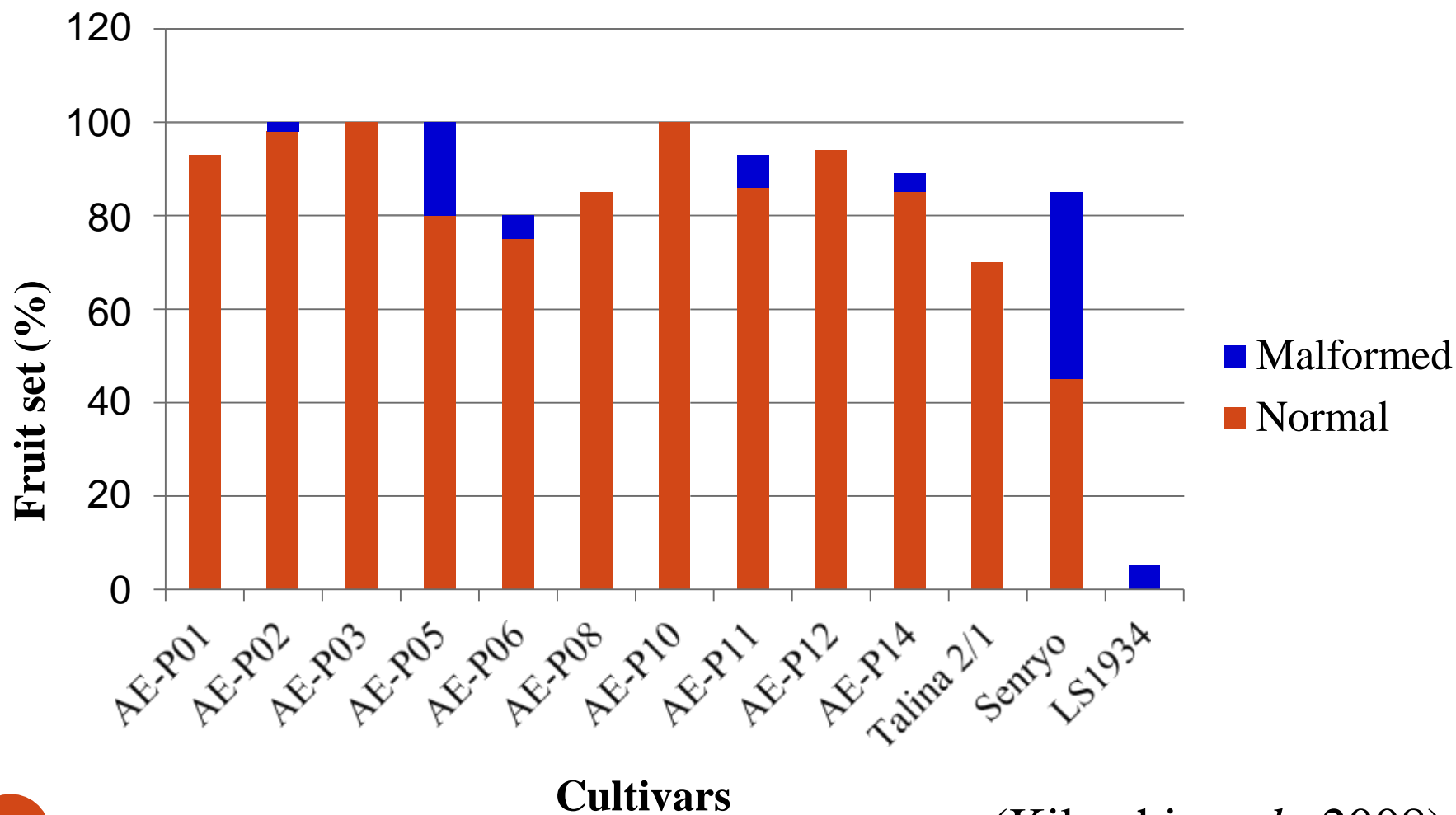


Development of parthenocarpic eggplant lines



(Kikuchi *et al.*, 2008)

Fruit setting ability of parthenocarpic brinjal inbred lines



Development of parthenocarpic F₁ hybrid “Anominori”



AE PO8

×



AE PO1



Anominori

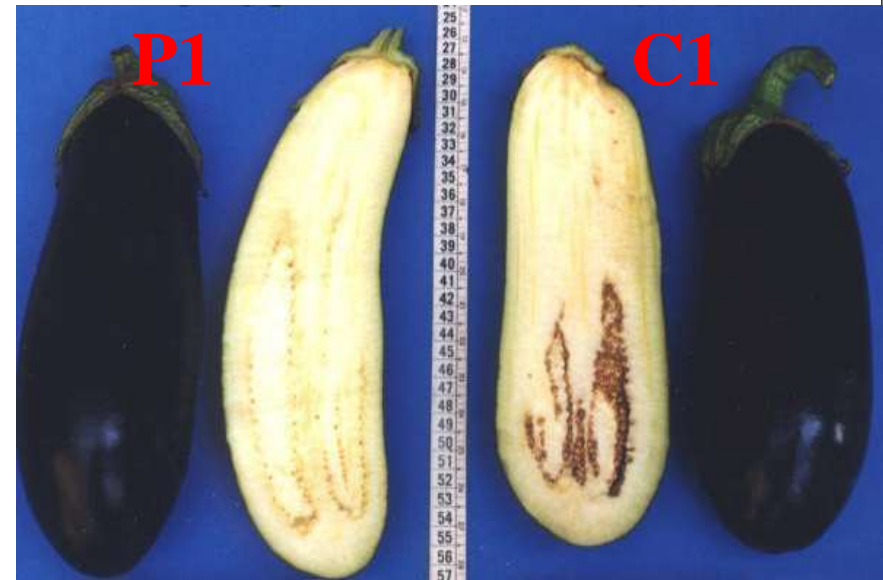
(Saito *et al.*, 2009)

Comparison of parthenocarpic ability in eggplant cultivars

Cultivars	Abscised flowers		Malformed fruits		Parthenocarpic fruits	
	(%)	SE	(%)	SE	(%)	SE
Anominori	45.0	12.6	0.0	0.0	55.0	12.6
AE-P08	40.0	11.0	0.0	0.0	60.0	11.0
AE-P01	42.0	9.2	0.0	0.0	58.0	9.2
Mileda	100.0	0.0	0.0	0.0	0.0	0.0
Talina 2/1	100.0	0.0	0.0	0.0	0.0	0.0
Senryou Nigou	95.0	5.0	5.0	5.0	0.0	0.0
Chikuyou	80.0	8.2	20.2	8.2	0.0	0.0
Nakate Shinkuro	90.0	10.0	10.0	10.0	0.0	0.0

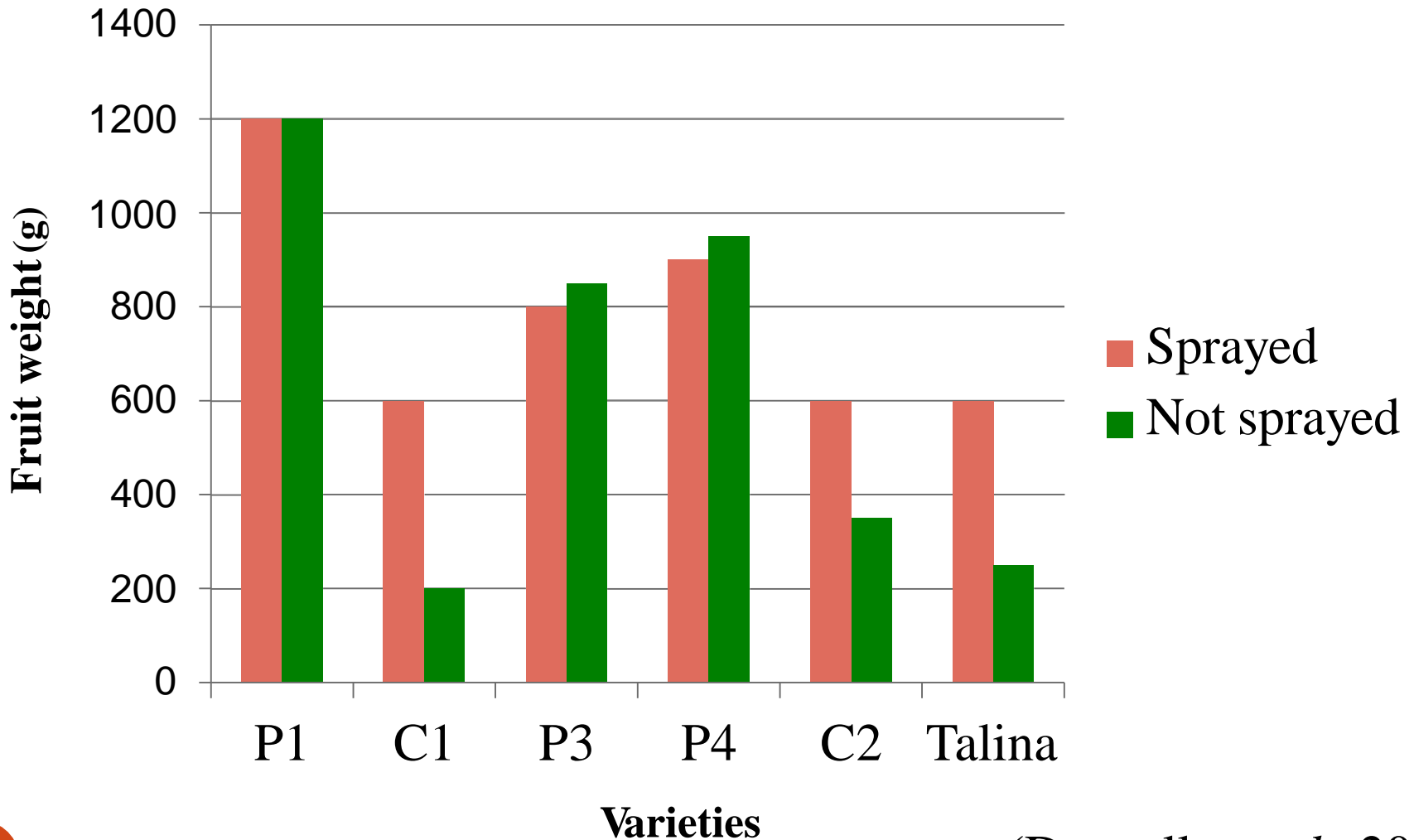
Transgenic parthenocarpic brinjal

- ❖ P1, P3 and P4
- ❖ Tal1/1 x DR2 *DefH9-iaaM* (P1)
- ❖ Tina x DR2 *DefH9-iaaM* (P3)
- ❖ Tal1/1 *DefH9-iaaM* x Tina (P4)
- ❖ C1 and C2 isogenic to P1 and P4



(Donzella *et al.*, 2000)

Performance of transgenic parthenocarpic lines during early winter

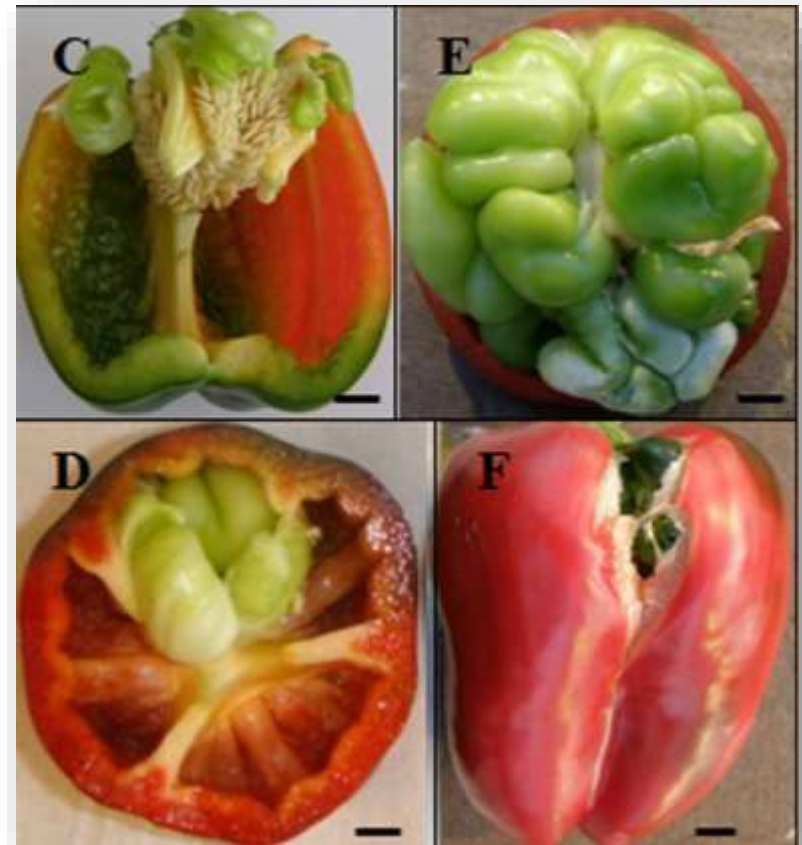


Capsicum



Parthenocarpy in capsicum

- ❖ Positive correlation-
parthenocarpy and carpelloid like
structures (CLS)
- ❖ Abnormal ovule primordia arose-
placenta and transformed into CLS



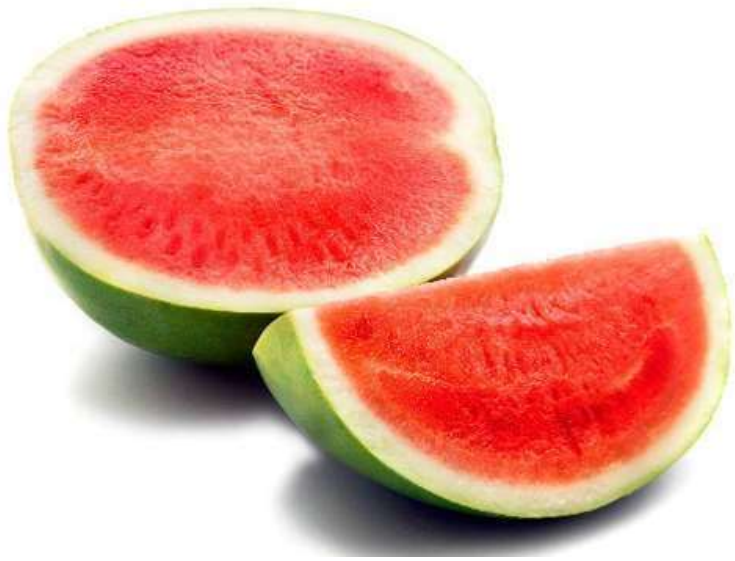
(Tiwari *et al.*, 2011)

Parthenocarpic ability of pepper genotypes

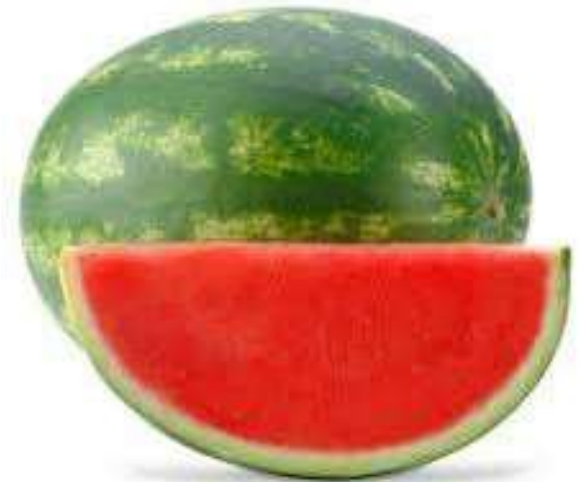
Genotypes	Zero seeds/fruit (%)		<5 seeds/fruit (%)	
	10° C	20° C	10° C	20° C
Line 3	100	73	100	82
Line 1	96	49	97	91
Lamuyo A	78	10	84	16
Lamuyo B	70	0	89	3
Gen A	64	2	83	6
Gen B	70	10	88	15
Gen C	63	7	83	31
Bruinsma Wonder	51	9	74	12
Serena	66	13	89	24
Orlando	9	2	22	2
Mazur	20	5	33	7

Analysis of segregating population for parthenocarpic fruit set

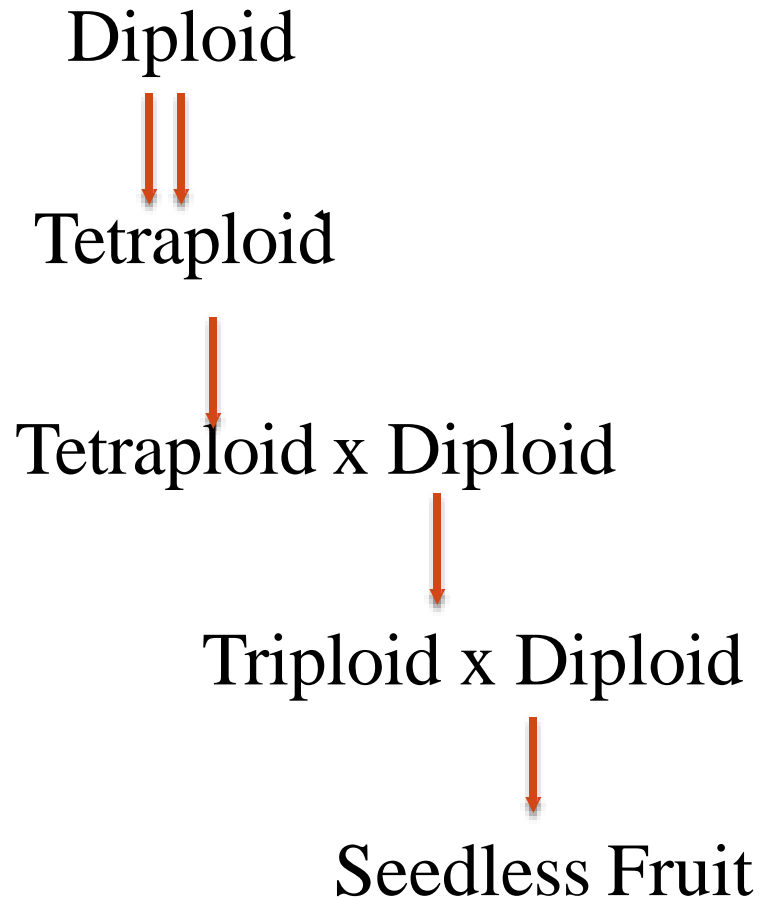
Crossing	Generation	Expected ratio	Total	Parthenocarpic fruits			
				O	E	X ²	P
Line 3 x Lamuyo B	F ₂	1:3	42	10	10.5	0.03	0.86
	F ₁ x Line 3	1:1	41	20	20.5	0.02	0.88
Line 3 x OR F ₂	F ₂	1:3	62	17	15.5	0.19	0.66
Line 3 x Parco	F ₂	1:3	24	5	6	0.22	0.64



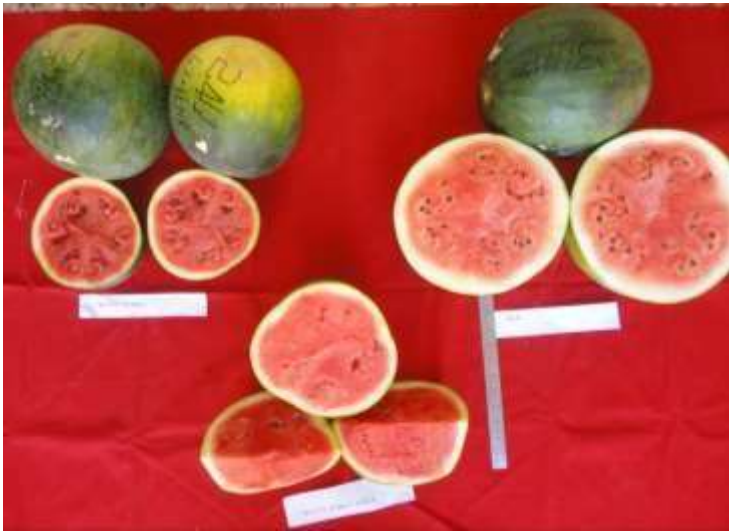
Watermelon



Seedless watermelon



Seedless watermelon varieties from KAU



Red seedless

(KAU-CL-TETRA 1 x CL-4)



Yellow seedless

(KAU-CL-TETRA 1 x CL-5)

Yellow fleshed seedless watermelon- FIRST IN INDIA



Dr. B. Singh , National Co-ordinator, Vegetable Crops, ICAR testing hybrid

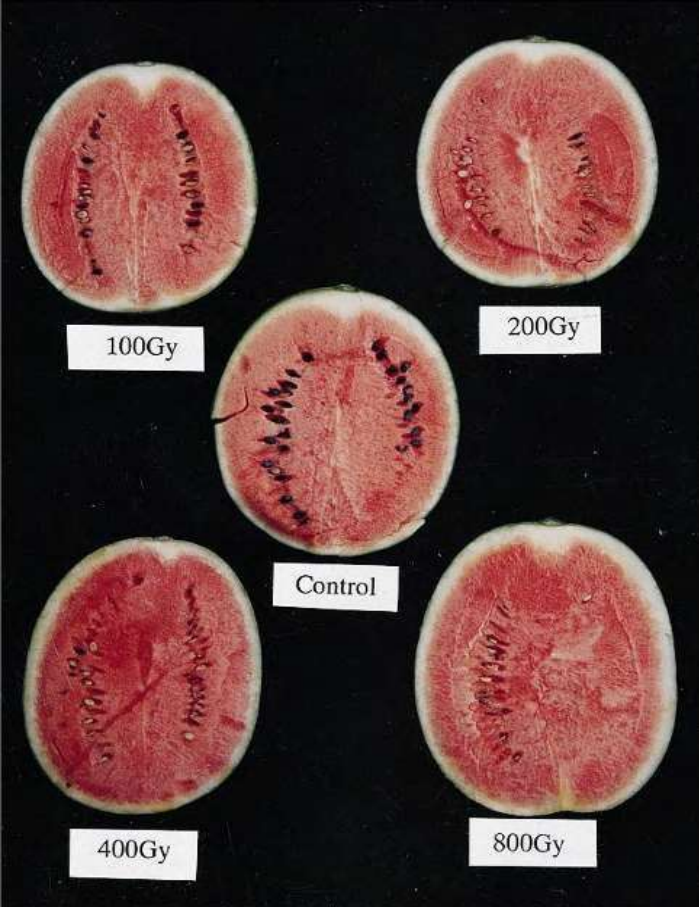
Effect of soft- X- irradiation on fruit set of watermelon

Cultivar	X – ray dose (Gy)	Treated flowers (number)	Fruit set (%)
Benikodama	0	51	39.2
	800	46	43.5
Fujihikari TR	0	54	64.8
	800	60	66.7

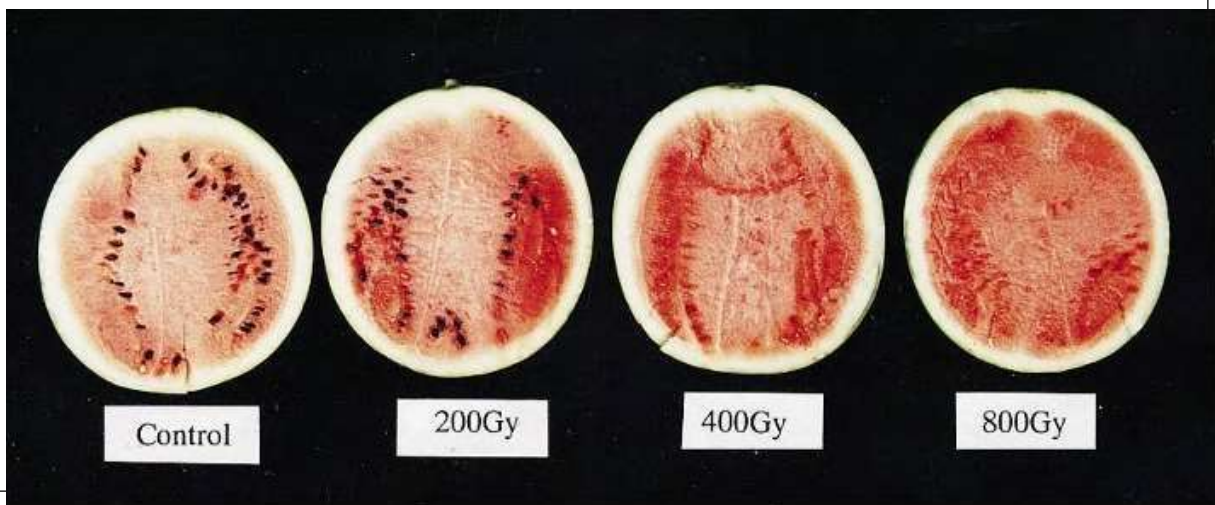
(Sugiyama and Marishitha, 2000)

Soft X-ray irradiation on watermelon varieties

Benikodama



Fujihikari TR



Parthenocarpy in other vegetables

□ Ivy gourd



□ Pointed gourd



Limitations

- ❖ Lack of stability and uniformity in the expression of parthenocarpy
- ❖ Small sized fruits
- ❖ Presence of knots or malformed fruits
- ❖ Hampers the production of commercial seeds

Conclusion

- ❖ Efficient tool to obtain stable yields under adverse conditions
- ❖ Seedlessness for processing industry
- ❖ *DefH9-iaaM* gene might be used to improve yield and quality of other vegetable crops

Future thrust

- ❖ High level and stable parthenocarpy
- ❖ Combining several parthenocarpy genes
- ❖ Developing parthenocarpy in high value crops
- ❖ Combining parthenocarpy with male sterility



THANK YOU

