



VIIth International Congress on Cactus Pear
and Cochineal

**Growing cactus pear *O. ficus-indica* (L.) Mill.
The contribution of the scientific research on
plant ecophysiology and biology**

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In 1993, when the CACTUSNET was created, international cooperation among Scientists working on cacti was nihil.

Scientific information delivered to growers was not consistent and updated.

Many questions have been addressed concerning all major aspects related to fruit production and quality.

Numbers for cactus Research in the last 20 years

- **360** papers in the ISI web of science (1990-2010).
- **573** citations for "*Opuntia ficus-indica*" in the CAB (2000-2010).
- **192** papers published in the Acta for Cactus Pear & Cochineal Symposia, since 1992).
- **432** Authors in Acta, 1992-2007.

Numbers for cactus Research in the last 20 years (Symposia)

Papers

Authors

Chile

28

37

S. Africa

23

46

Tunisia

40

91

Mexico

42

80

Brazil

59

178

MAJOR INNOVATIONS:

Genetic Resources:

- ✓ genotype identification and description;
- ✓ morphological and biological analysis worldwide;
- ✓ genotype characterization (from isoenzymes to microarrays and DNA analysis);
- ✓ breeding;
- ✓ germplasm collections.

MAJOR INNOVATIONS:

Orchard lay out and management:

- ✓ orchard planting and lay-out;
- ✓ tree pruning;
- ✓ LAI measurement;
- ✓ plant nutrition and fertilization;
- ✓ water requirement and irrigation management;
- ✓ orchard floor management.

Planting Density

Sicily: 4 m in the row and 6 m between the rows
416 plants/hectares (22 ton/ha)

Mexico: 2 m in the row and 4 m between the rows
1250 plants/hectares (20 ton/ha)

Israel: 1.5 m in the row and 4 m between the rows
1600 plants/hectares (21 ton/ha)



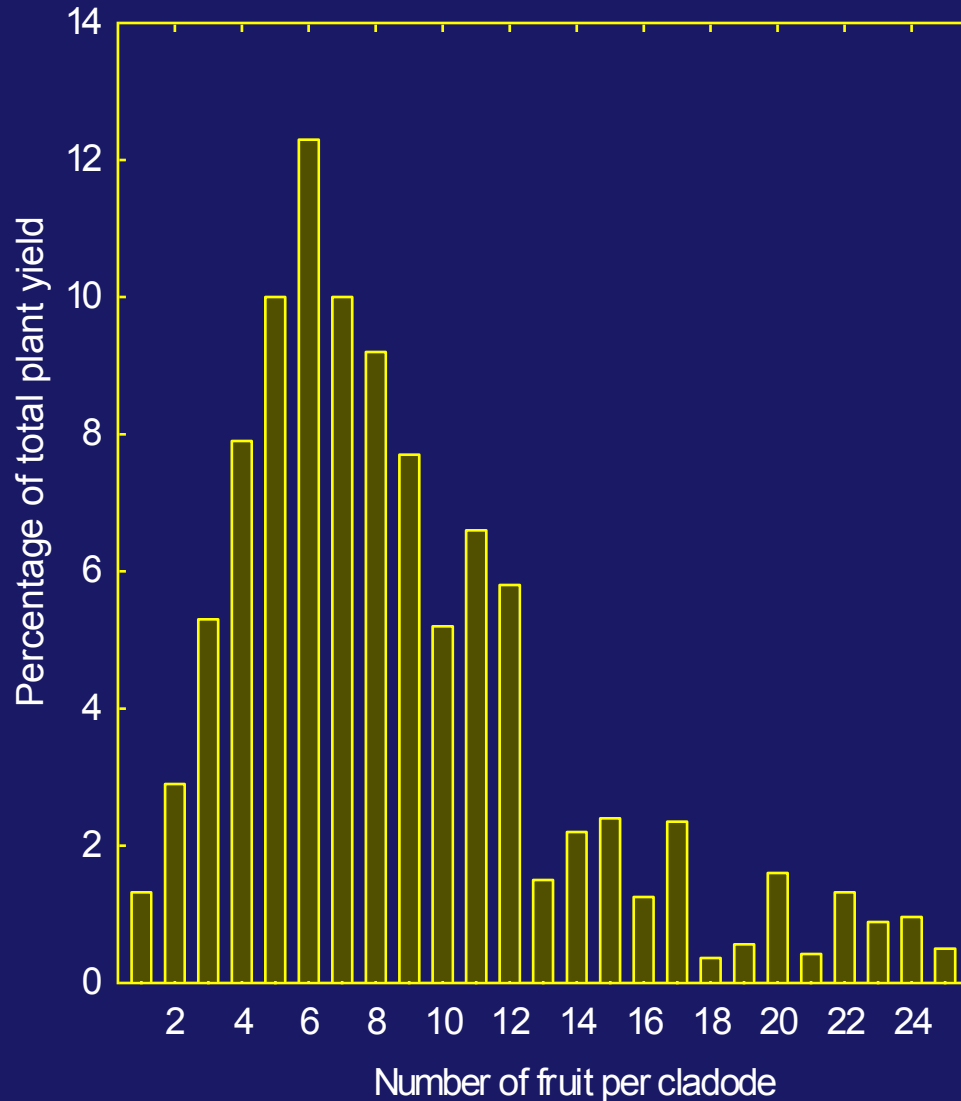


MAJOR INNOVATIONS:

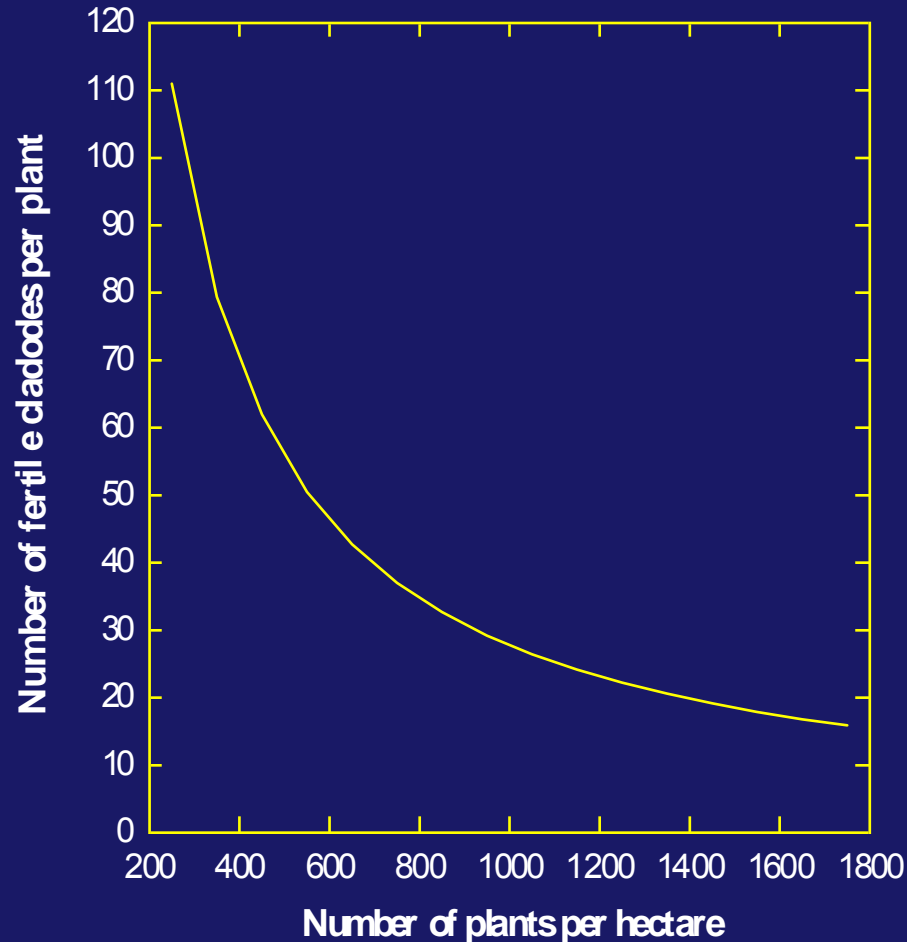
Reproductive biology:

- ✓ reflowering potential;
- ✓ environmental factors affecting reproductive potential;
- ✓ plant architecture and reproductive sites;
- ✓ biennial bearing;
- ✓ variability of fruit yield.

Relative cladode contribution to plant yield in relation to its fertility

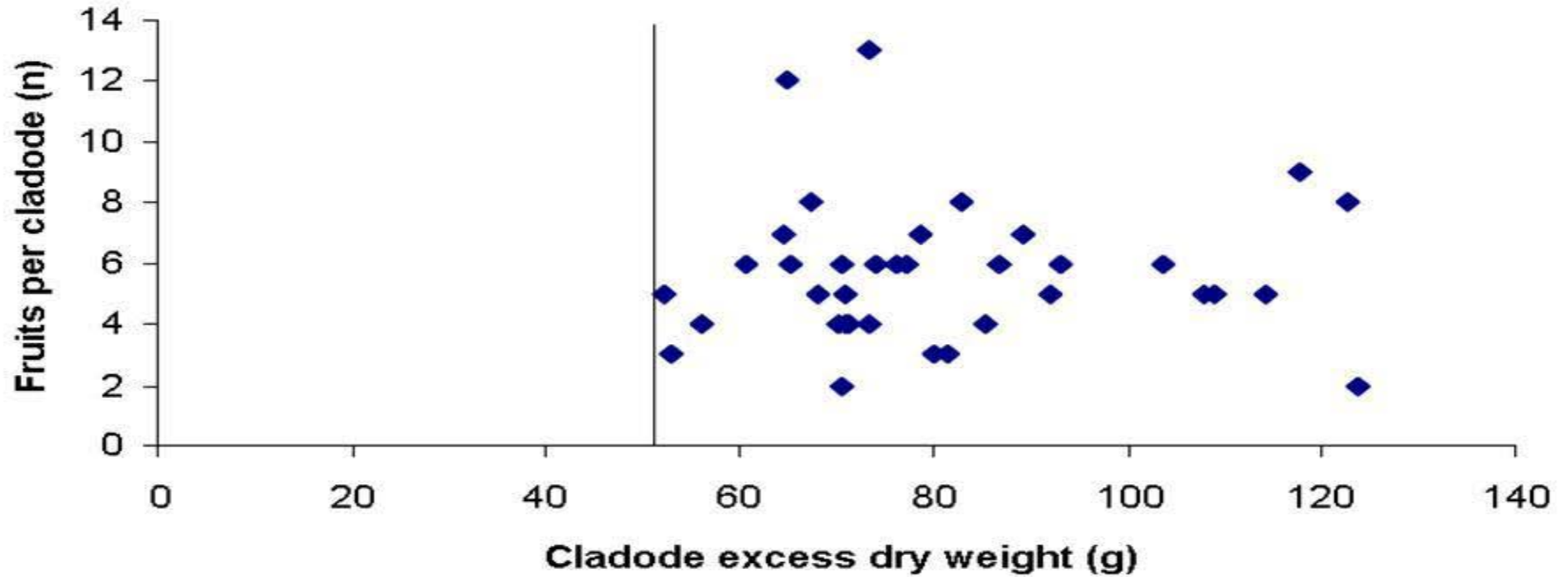


Number of fertile cladodes needed to get a crop yield of 20 t ha^{-1} , given 6 fruits (120 g) per cladode, in relation to orchard density.

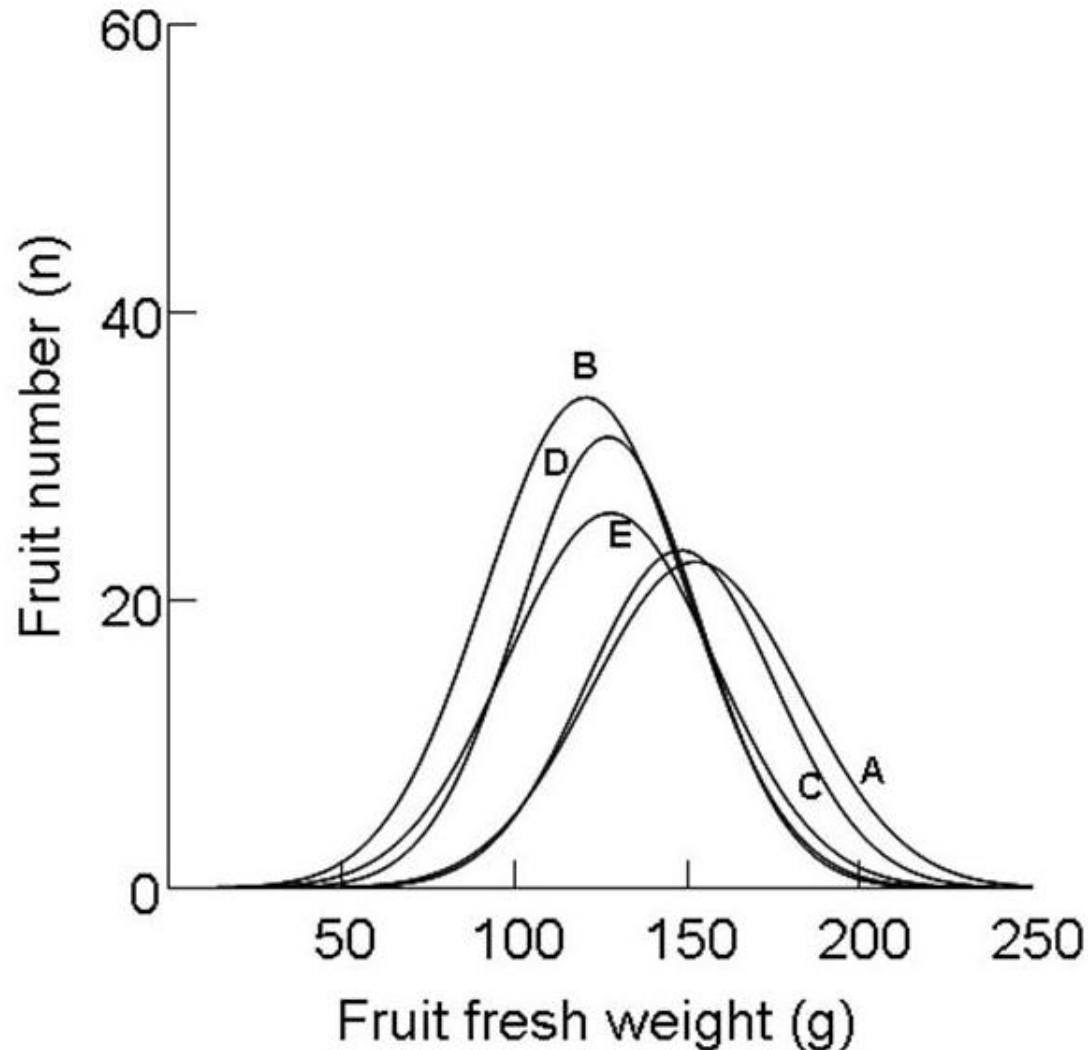


Cladode dry weight in excess of the minimum dry weight for its surface area vs number of fruits on that cladode.

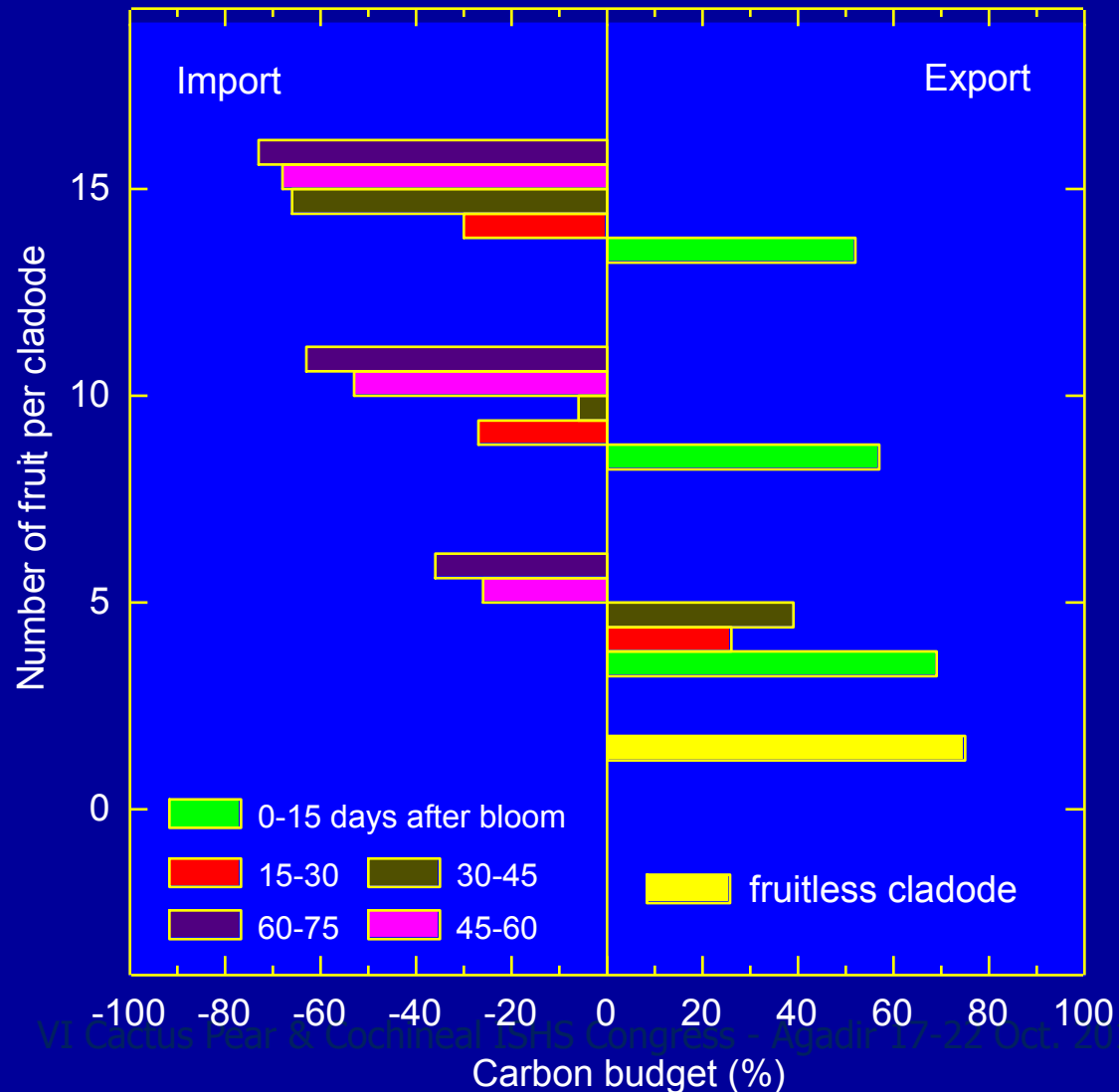
Figure 15



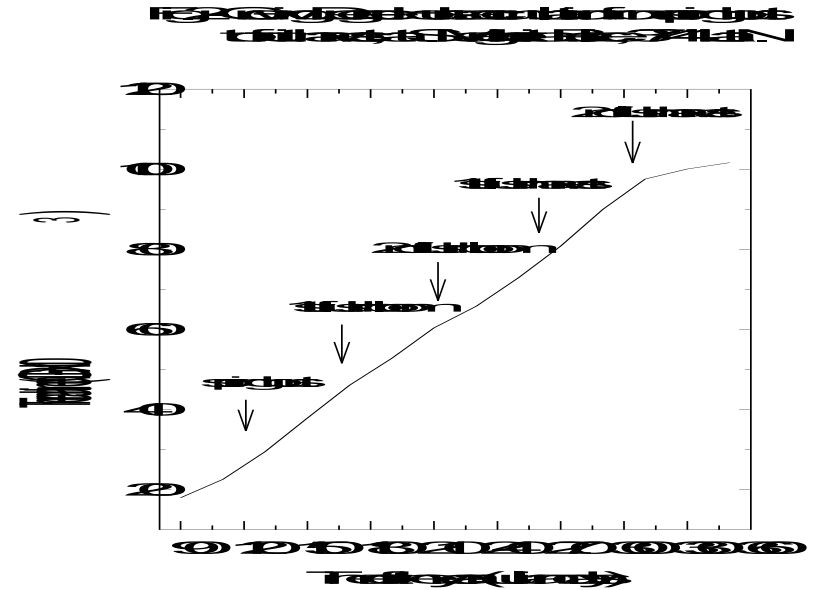
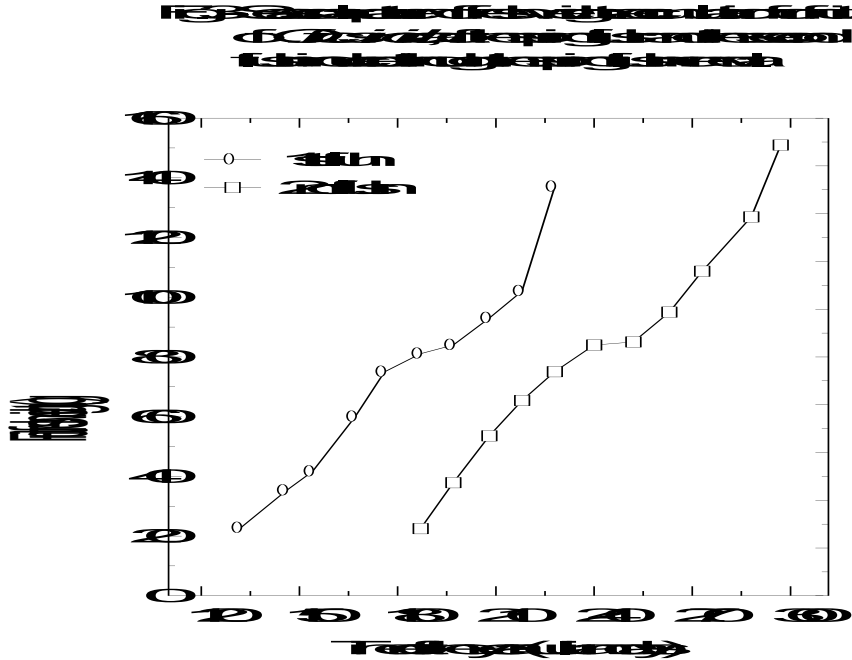
Relationship between fruit weight and n° of fruit per tree in *O. ficus-indica* trees, cultivar *Gialla*.



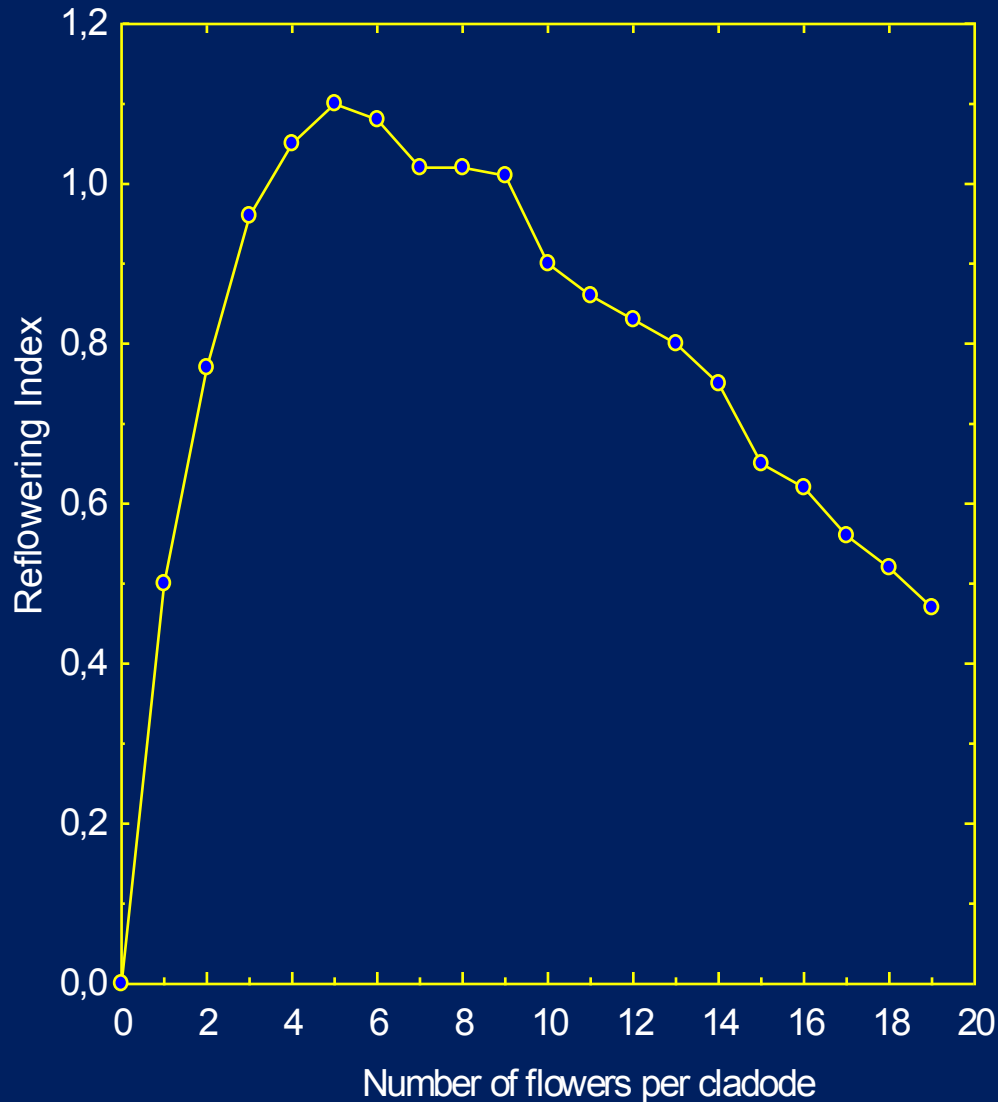
Carbon flux in cladode of *O. ficus-indica* with and without fruit, during fruit growth



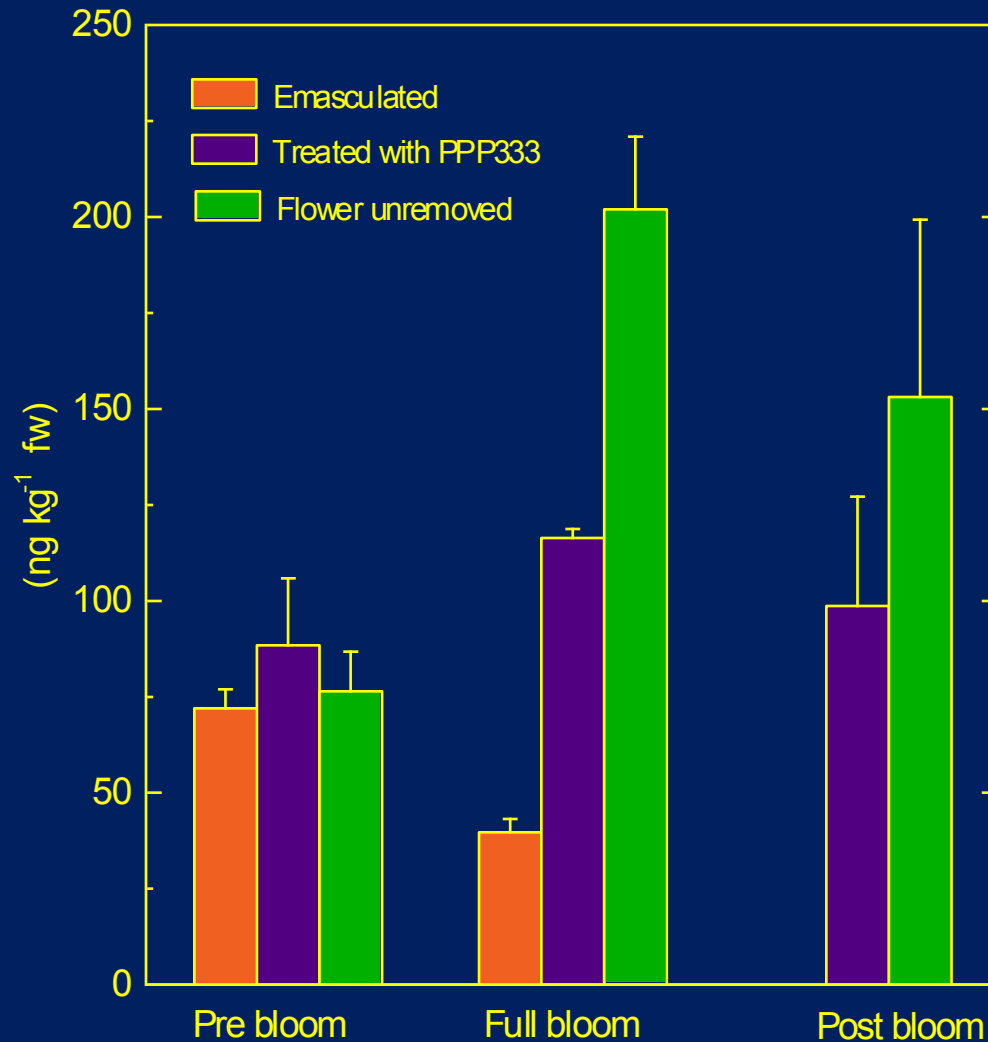
GROWTH OF SUMMER AND LATE RIPENING FRUITS



Relationship between cladode natural fertility and its reflowering aptitude *O. ficus-indica*



Evolution of GA₃ content in flowers of *O. ficus-indica* at different bloom stages



MAJOR INNOVATIONS:

Fruit characteristics:

- ✓ fruit growth and ripening pattern;
- ✓ fruit ripening period (out-of-season crop);
- ✓ fruit harvest and quality index;
- ✓ fruit quality parameters;
- ✓ fruit nutraceutical potential;
- ✓ fruit minimal processing;
- ✓ post harvest physiology and management.

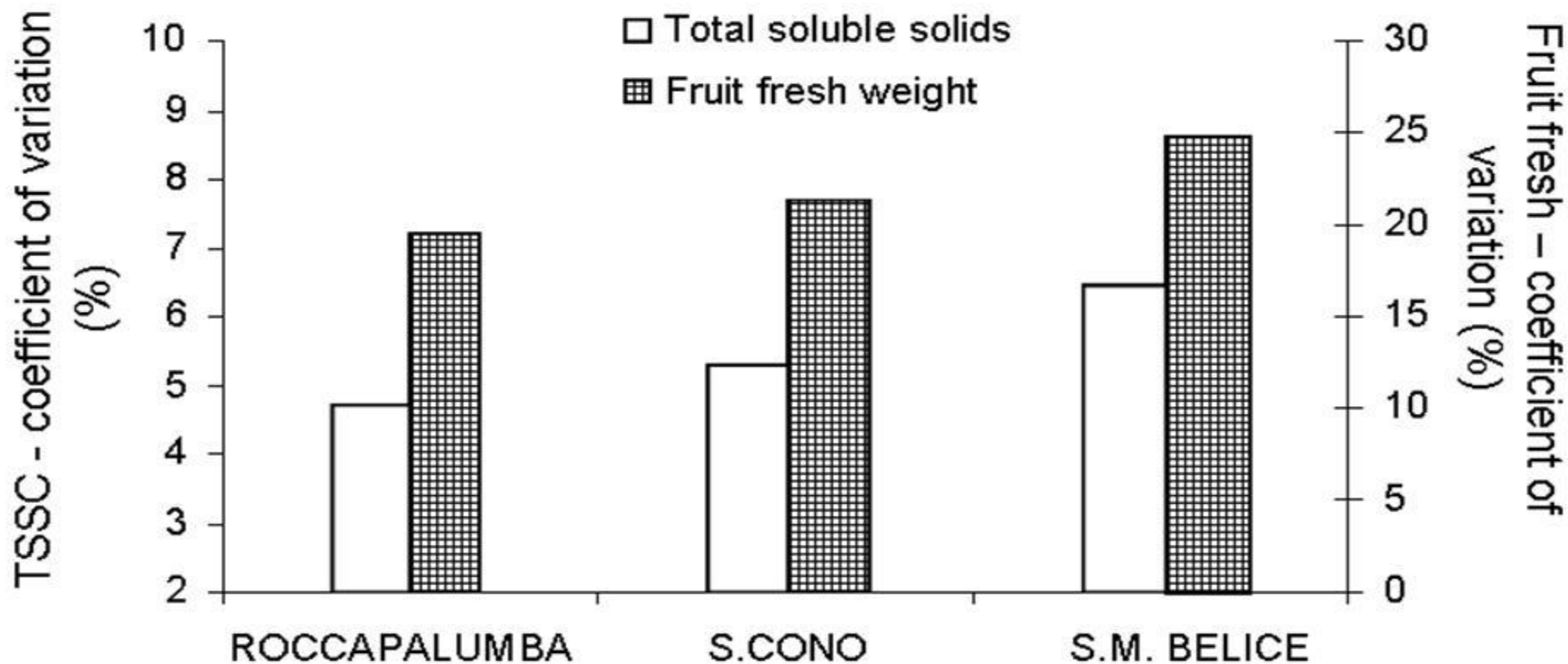
Analysis of variance of quality parameters of *O. ficus-indica* fruits, cultivar *Gialla* and *Rossa*, coming from three different growing sites, in Sicily.

	Weight (g)	TSS (% Brix)	Percent Flesh (%)	pH	Titratable Acidity (% NaOH)	Height/ Width
Site	**	**	ns	ns	ns	*
Cultivar	**	ns	ns	ns	ns	ns
Altitude	**	**	ns	ns	ns	**
Site x Cultivar	ns	ns	ns	ns	ns	ns

*=significant at $p < 0.05$; **=significant at $p < 0.01$; ns=non significant (Tukey's test).

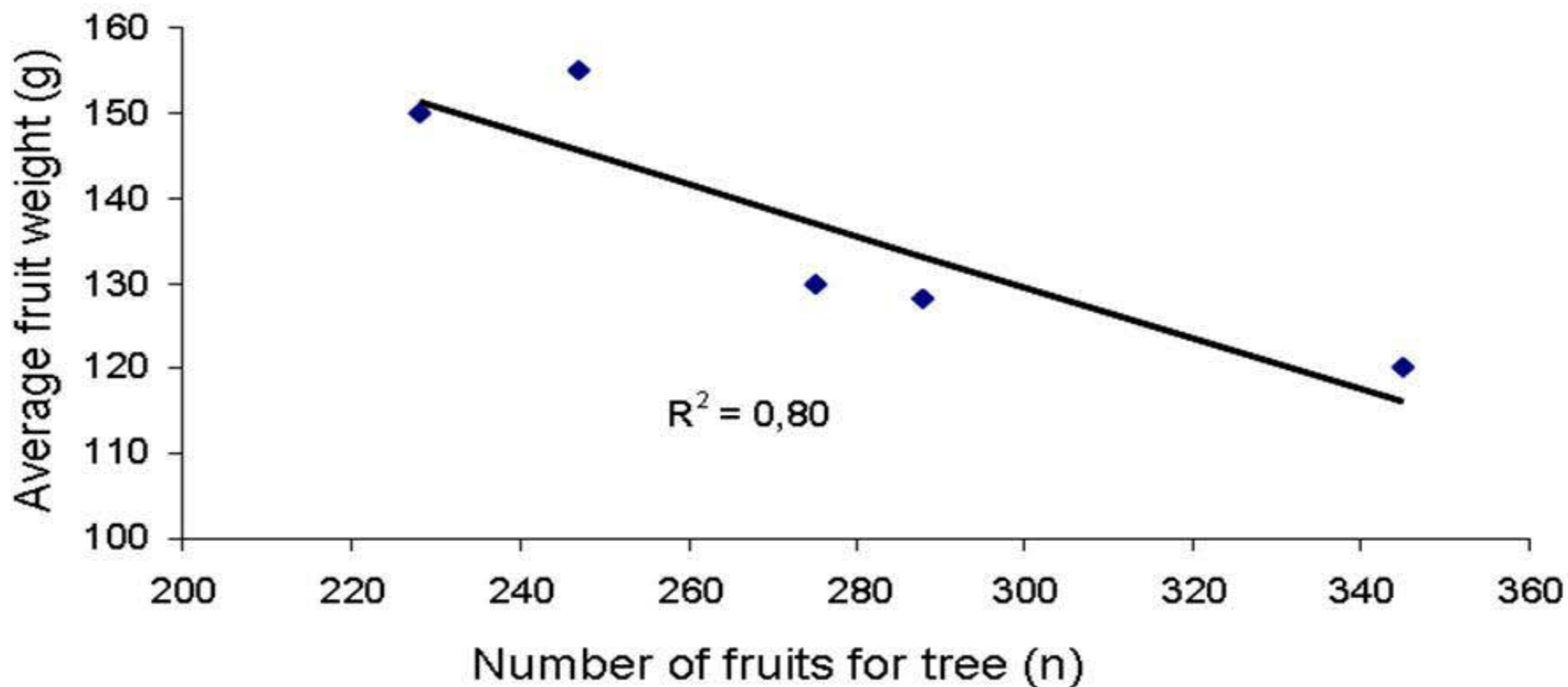
Variability of fruit fresh weight and TSSC in five 8-years-old *Opuntia ficus-indica* trees, cultivar *Gialla*.

Figure 7

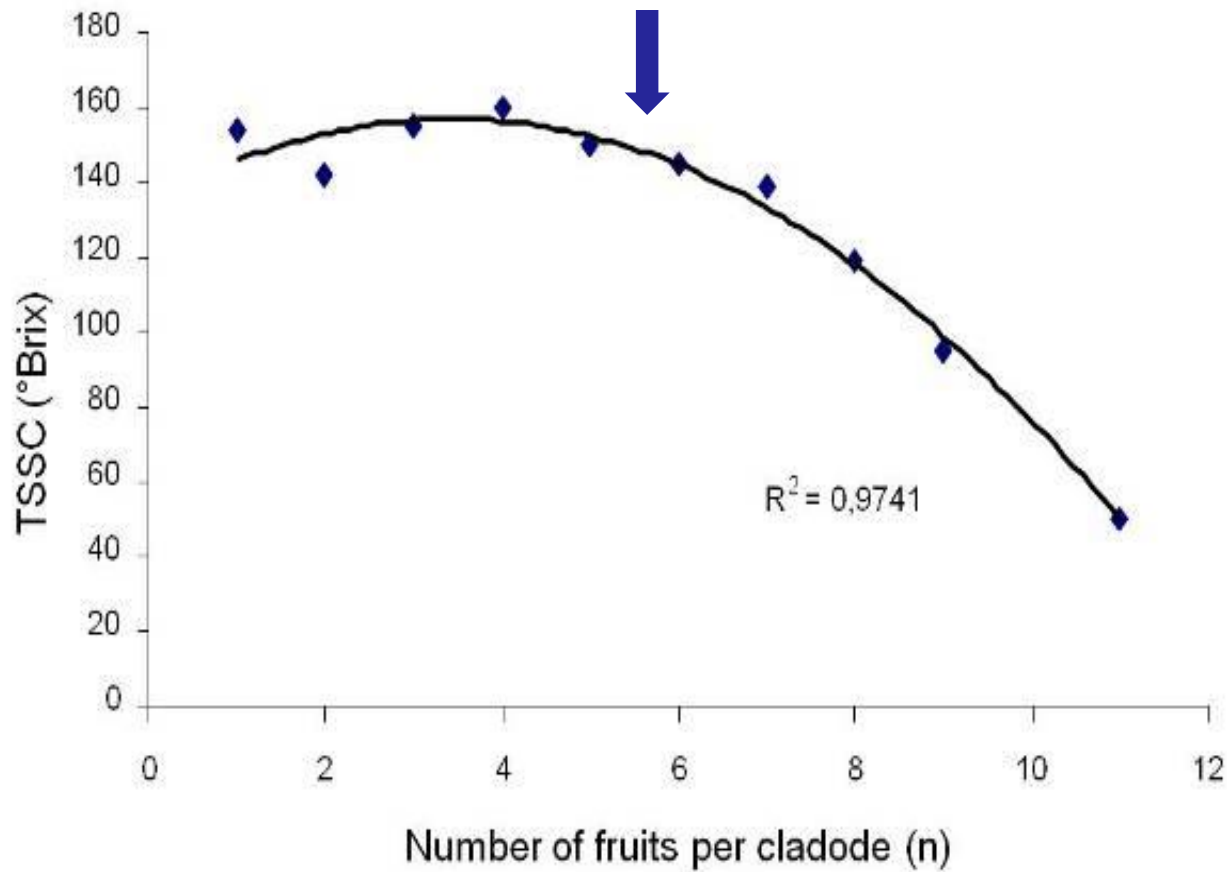


Relationship between average fruit weight and number of fruit per tree in five 8-years-old *Opuntia ficus-indica* trees, cultivar *Gialla*.

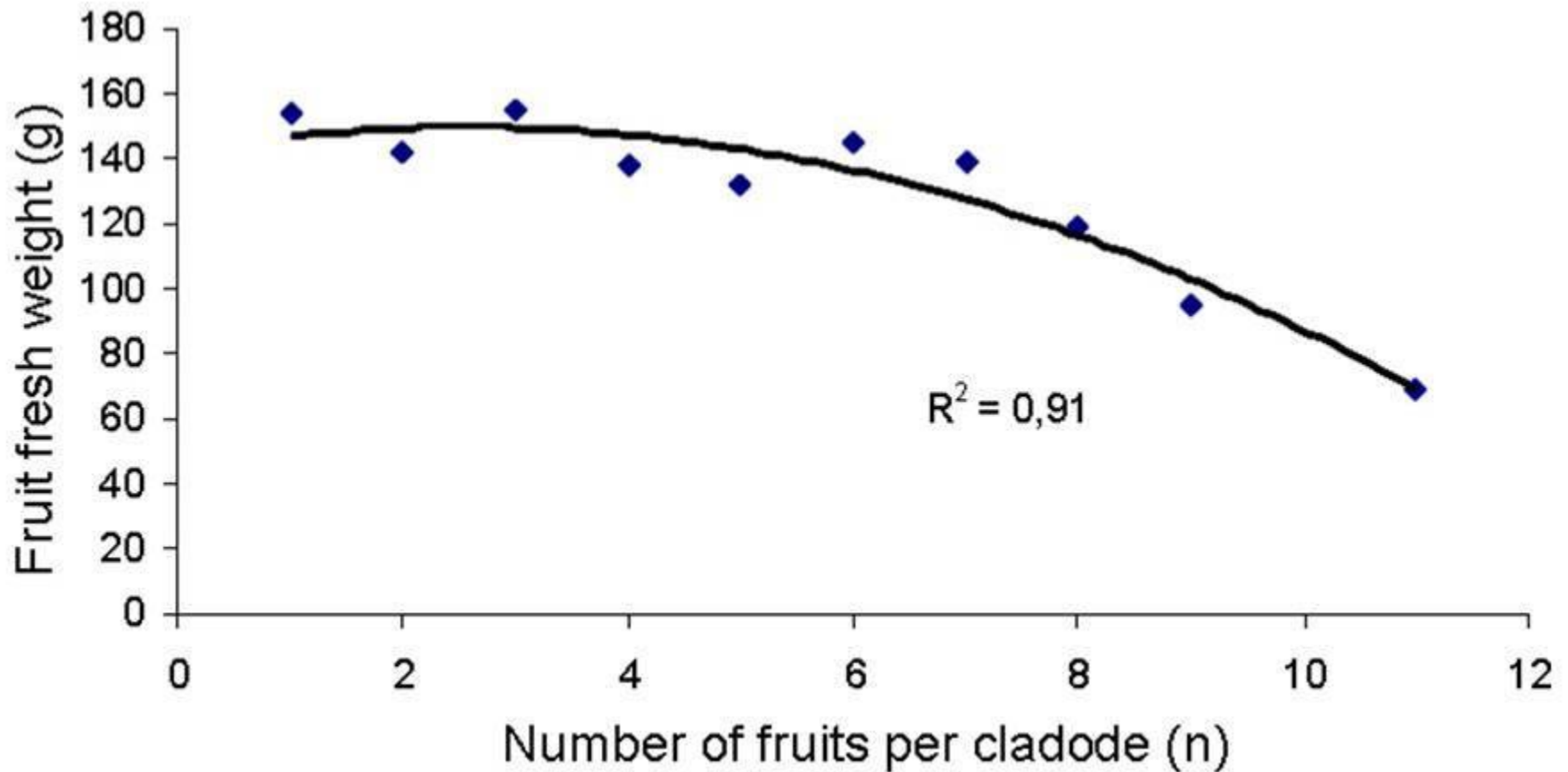
Figure 10



Relationship between total soluble solid content (TSSC) and cladode crop load



Relationship between average fruit fresh weight and number of fruits per cladode in five 8-years-old *Opuntia ficus-indica* trees, cultivar *Gialla*.



Quality parameters for *O. ficus-indica*, cv *Gialla* fruits, in relation to canopy site and intercepted Photosynthetic Active Radiation (PAR)

Fruit parameters	Canopy site		
	Bottom (0-1 m)	Middle (1-2 m)	Top (2-3 m)
	PAR = 15 mol m ⁻² day ⁻¹	PAR = 18 mol m ⁻² day ⁻¹	PAR = 22 mol m ⁻² day ⁻¹
Fruit weight (g)	127.0 a	139.5 b	146.6 c
TSSC* (° Brix)	14.9 ns	15.0	57.0
Percent flesh (%)	55.1 ns	56.3	56.1

TSSC= Total Soluble Solids Content. Different letters indicate significant differences and ns = not significant differences within the row at p=0.05 (Tukey's test).

MAJOR INNOVATIONS:

Ecophysiology and environmental aspects:

- ✓ environmental aspects of plant and fruit growth;
- ✓ Carbon balance at cladode, plant and orchard level;
- ✓ Plant response to global change;
- ✓ organic production.

Dry matter cumulated in one year in a 8-year-old cactus pear tree

Vegetative flush	Flowers and Fruit (kg dm)		Current-year-cladodes (kg dm)	
	Mean	± SE	Mean	± SE
I	3,06	0,64	3,75	0,13
II	6,34	0,25	12,20	0,70
TOTAL	9,40	0,34	15,95	0,76

Secondary growth of 1-year-, 2-year- and >2-year-old cladodes

	1-year-old		2-year-old		>2-year-old		Total	
	Mean	±SE	Mean	± SE	Mean	± SE	Mean	± SE
Whole tree (kg dm)	26,06	3,20	5,86	0,34	2,85	0,27	34,73	3,13
Single cladode (g dm)	150,21	13,2	60,13	5,54	8,14	7,82	50,12	4,31

Seasonal dry matter accumulation

	Mean	\pm SE
(kg tree ⁻¹)	58,7	6,0
(t ha ⁻¹)	16,2	1,7

Tree (m²) and Cladode (cm²) surface area

Surface area	Current-year		1-year-old		2-year-old		>2-year-old	
	mean	± SE	mean	± SE	mean	± SE	Mean	± SE
tree (m ²)	33,4	5,1	25,6	3,2	14,6	0,9	28,5	2,7
Cladode (cm ²)	1370,2	32,1	1553,8	17,8	1706,0	53,0	1746,8	53,0

Stem Area Index (SAI)

SAI	Current-year		1-year-old		2-year-old		>2-year-old		Total	
	mean	± SE	mean	± SE	mean	± SE	mean	± SE	mean	± SE
tree	1,70	0,3	1,3	0,2	0,74	0,1	2,89	0,3	6,63	0,5
orchard	0,95	0,1	0,73	0,1	0,42	0,1	1,62	0,2	3,72	0,3

MAJOR RELEVANT QUESTIONS:

✓ **How to increase fruit yield potential?**

plant fertility vs Cladode fertility

tree spacing vs plant architecture

✓ **How to reduce production costs?**

mechanization vs plant breeding

✓ **How to increase fruit quality and value?**

seasonal offer

fruit shape and color

seed number

fruit organoleptic and nutraceutical value

MAJOR RELEVANT QUESTIONS:

- ✓ **Plant nutrition and N balance**
- ✓ **Water requirement and irrigation management**
- ✓ **C balance and environmental impact of cactus pear orchard**