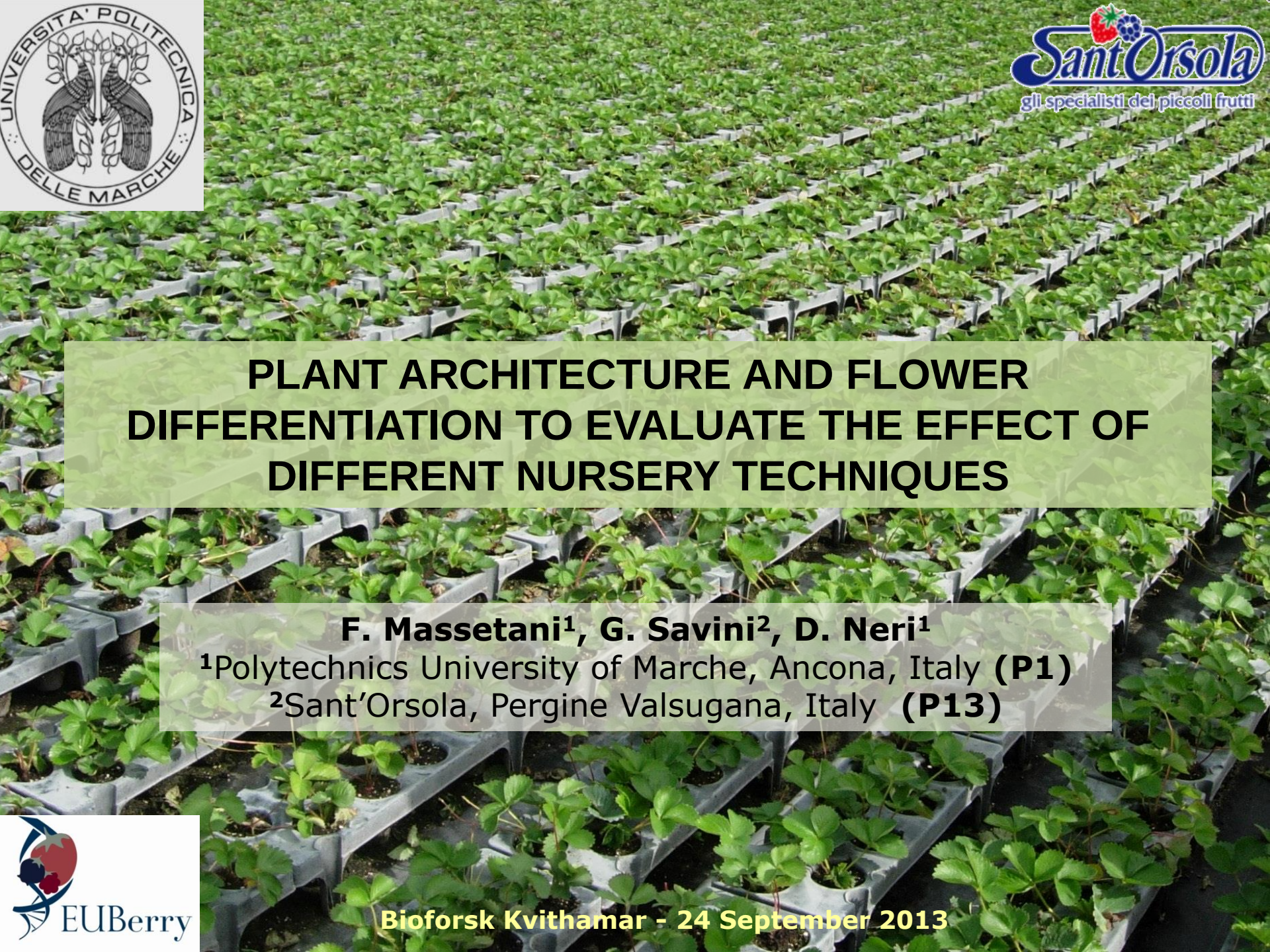


PLANT ARCHITECTURE AND FLOWER DIFFERENTIATION TO EVALUATE THE EFFECT OF DIFFERENT NURSERY TECHNIQUES

F. Massetani[1], G. Savini[2], D. Neri[1]
[1]Polytechnics University of Marche, Ancona, Italy **(P1)**
[2]Sant'Orsola, Pergine Valsugana, Italy **(P13)**

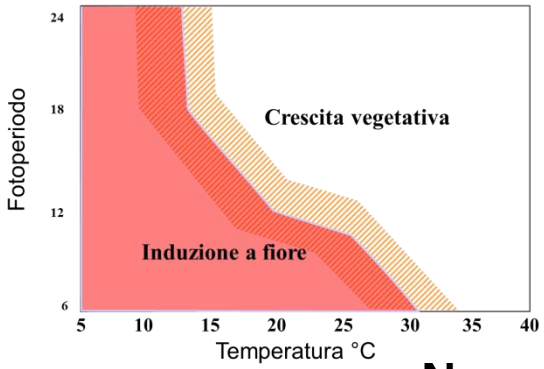
Bioforsk Kvithamar - 24 September 2013

- Task 2.1 Cultivation techniques for season extension
- Sub-task 2.1.1

Controlling plant development for season extension

i) the time of runner tip rooting and transplanting.
ii) regulated nutrient input.
iii) regulated water application.
iv) different plant types including fresh and cold-stored plants.
v) different temperature conditions and chilling requirements

FLOWER INDUCTION



Environment

- **temperature**
- **photoperiod**

Nursery techniques

- **time of runner tip rooting**

Plant growth

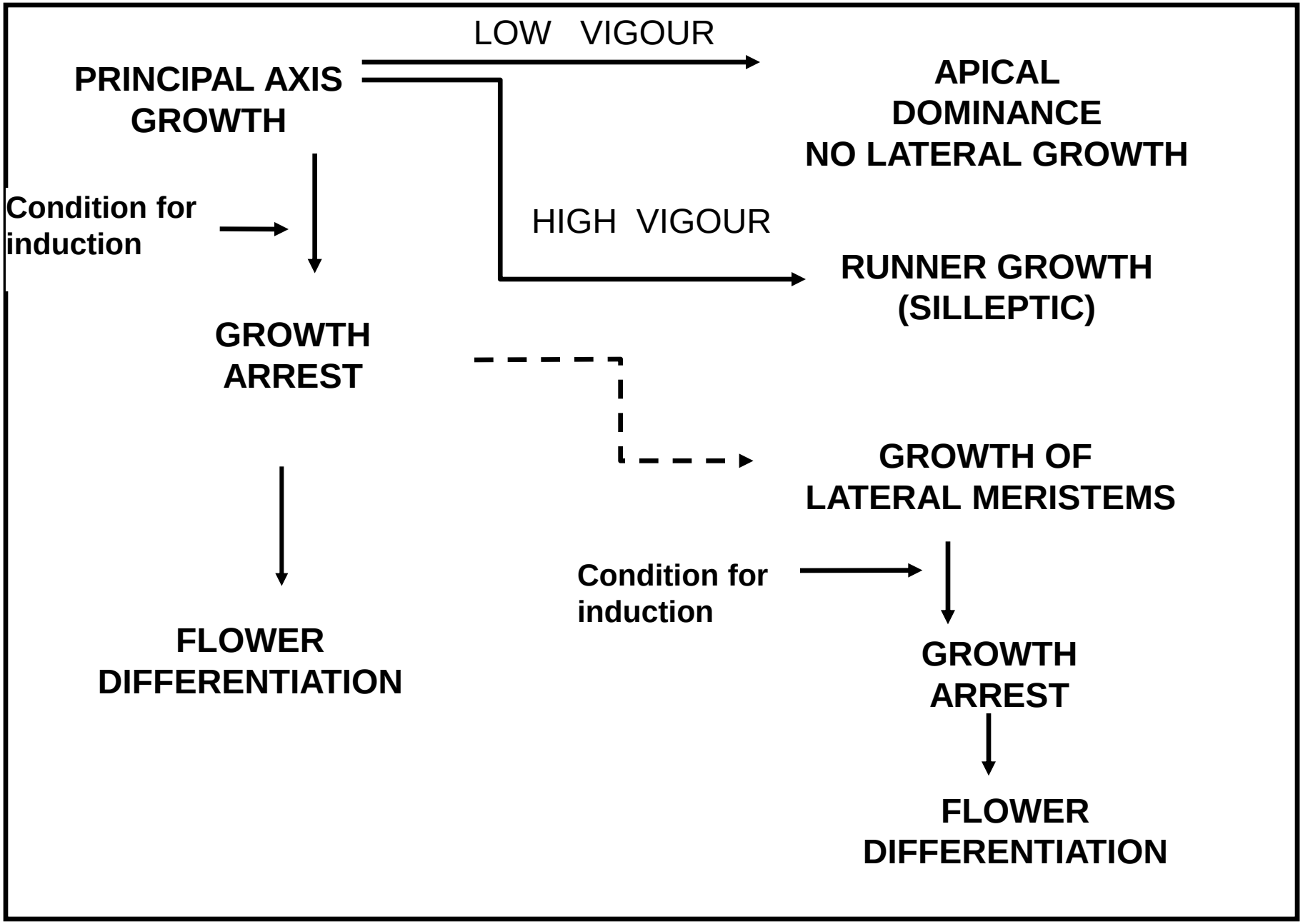
- **shoot to root ratio**
- **Carbon balance**

- **mineral nutrition**
- **small pot**
- **transplanting**
- **Leaf removal**

FLOWER INDUCTION

WITH DIFFERENT TECHNIQUES

- **MINERAL NUTRITION (**Shoot to root ratio**)** (Strik, 1985; Battey et al. 1998; Lieten; 2002; Bigey; 2002)
- **SHADING 85% (**Carbon Balance) (Kumakura and Shishido,1985)
- **LEAF REMOVAL (**Carbon Balance**)** (Thompson and Guttridge, 1960)
- **WATER STRESS (**Several factors**)** (Naumann, 1961)
- **TRANSPLANTING (**Shoot to root ratio**)** (Fujishighe, 1994)
- **SMALL POT (**Shoot to root ratio**)** (Fujishighe, 1994).


LOW VIGOUR
PRINCIPAL AXIS GROWTH
APICAL DOMINANCE NO LATERAL GROWTH
Condition for induction
HIGH VIGOUR
RUNNER GROWTH (SILLEPTIC)
GROWTH ARREST
GROWTH OF LATERAL MERISTEMS
Condition for induction
FLOWER DIFFERENTIATION
GROWTH ARREST
FLOWER DIFFERENTIATION

Plant architecture

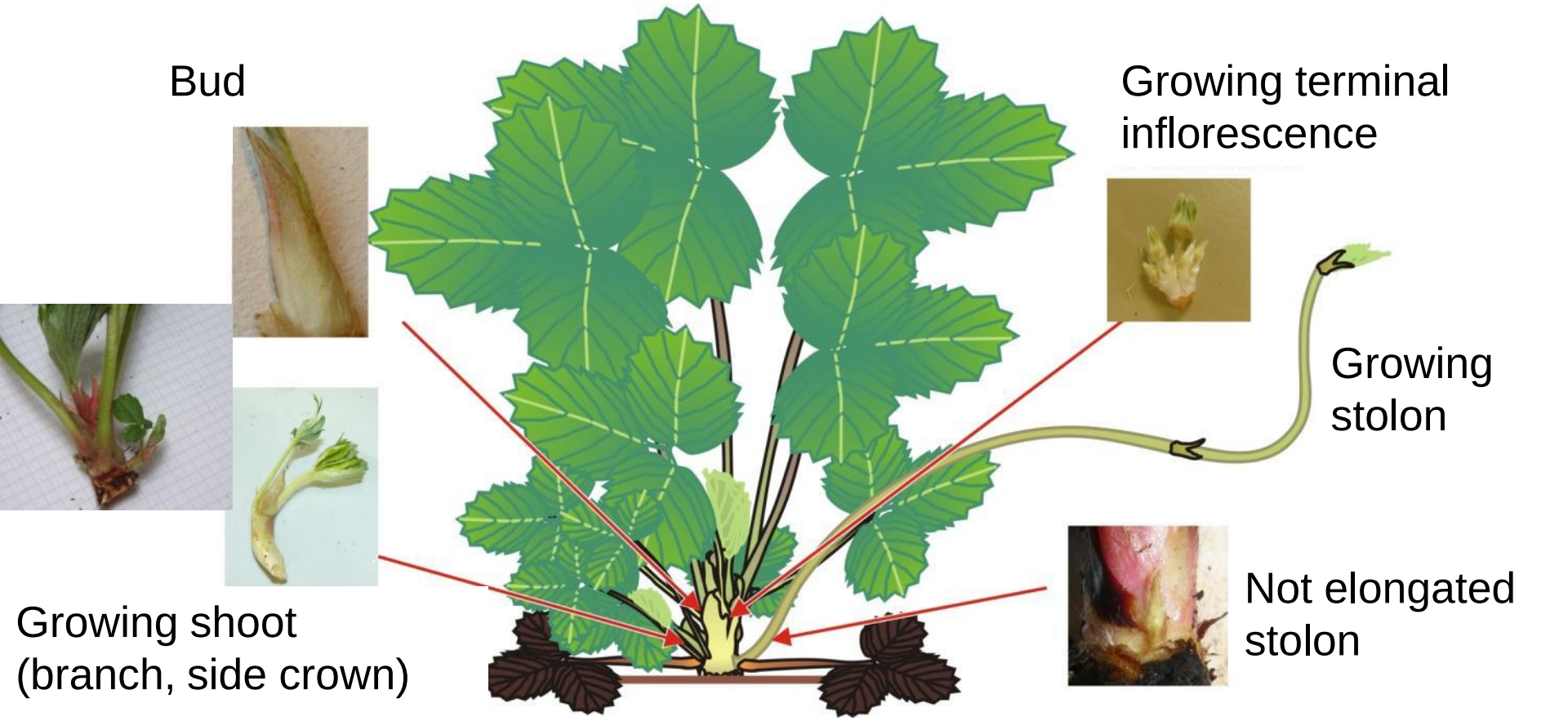
- The strawberry plant is a **herbaceous perennial rosette** and the stem or crown has secondary cambium activity.
- The **internodes are very short** and a number of long-petiole trifoliate **leaves are arranged spirally** on the axis.
- The **axillary meristems** may develop into **stolons** or **branch crowns**, with a regular positioning along the axis, and in strict relation with crown growth rate.
- Under favourable environmental conditions **floral induction occurs at the apex** of the crown.

Extension growth of the crown continues along the axis of the uppermost lateral meristem below the terminal inflorescence (extension crown - extension axis), thus giving a sympodial structure to the crown which is not apparent at **first sight**.

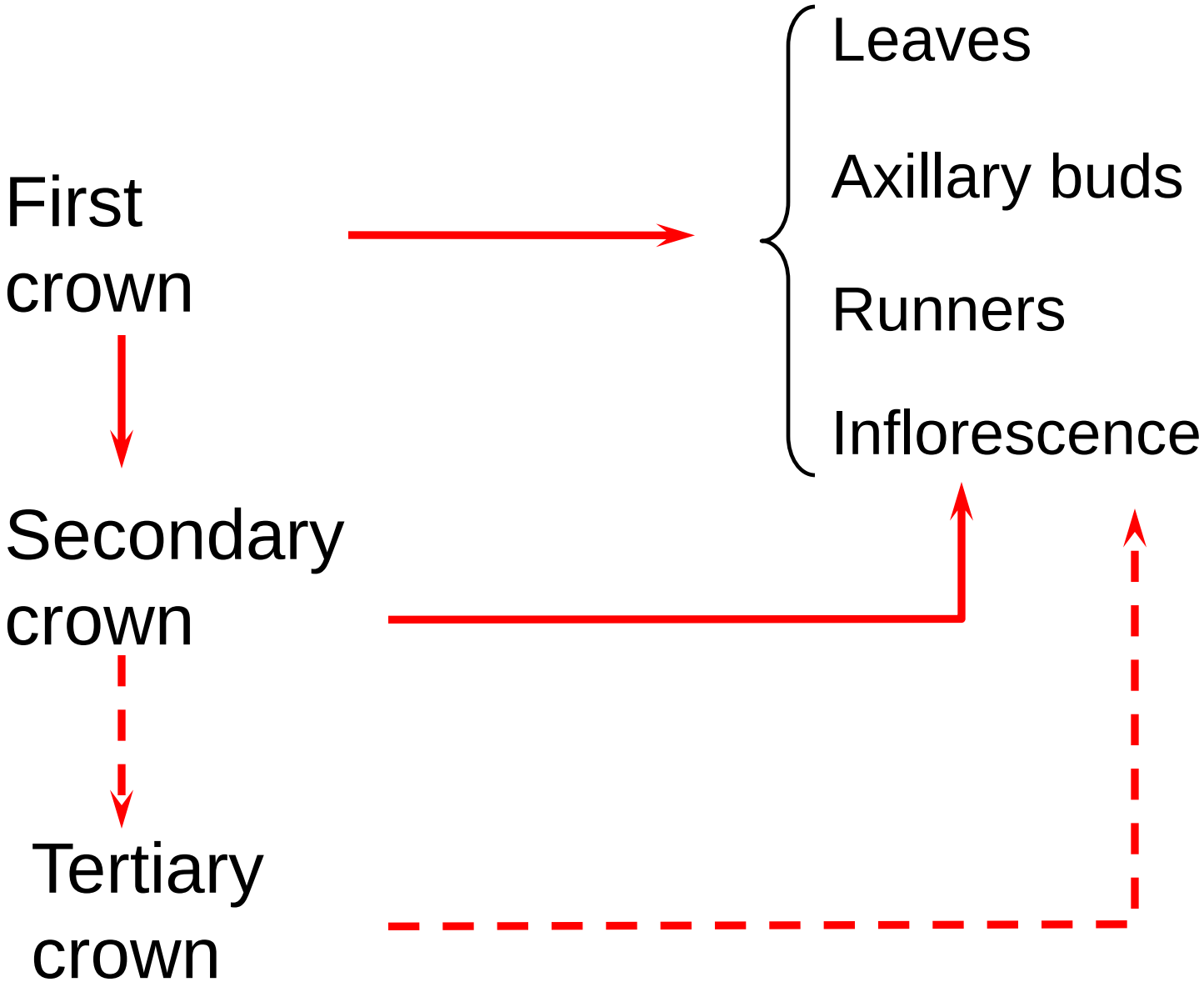
Savini et al 2005

Plant elements

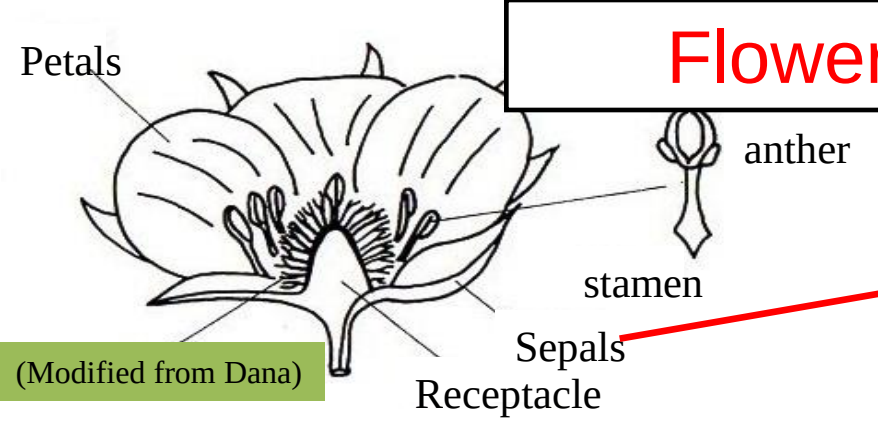
Bud fates: **branch (side crown)**
runner (long shoot)
dormant bud



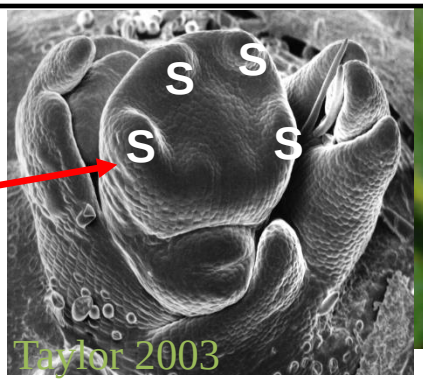
ORGANOGRAPHY

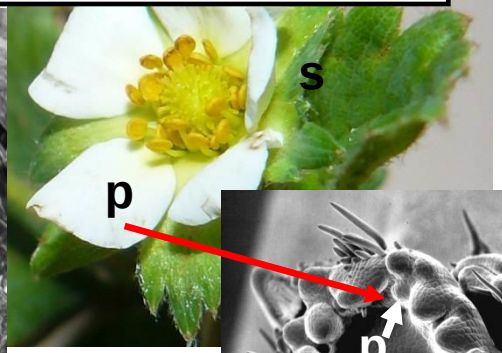


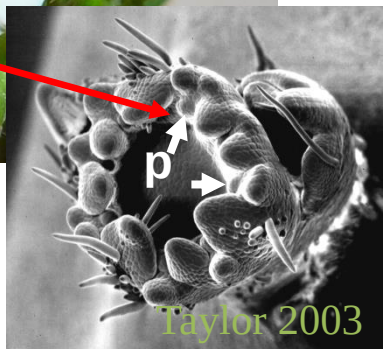
Flower differentiation stages



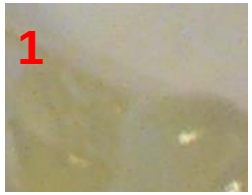
(Modified from Dana)







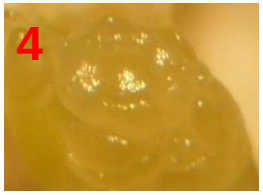
Vegetative apex



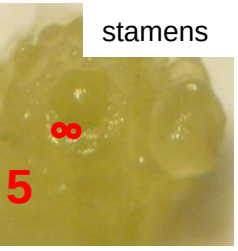
Primary flower

Sepals

Petals



Sepals + petals



Green anthers

Enclosed flower

Yellow anthers

(Neri et al, 2011)

0= vegetative apex
1= Primary flower primordium
2= Sepals initiation on primary flower
3= Petals initiation on primary flower
4= Sepals and petals are developed
5= stamens formation on primary flower
6= primary flower is enclosed by sepals and epidermal hairs initiated
7= primary flower are completed with green anthers
8= primary flower with yellow anthers
9= completely formed cluster
10= Start of flowering
11= Full bloom
12= Green fruits

Flower differentiated terminal apex

Undifferentiated terminal apex

Not expanded leaf with an axillary bud

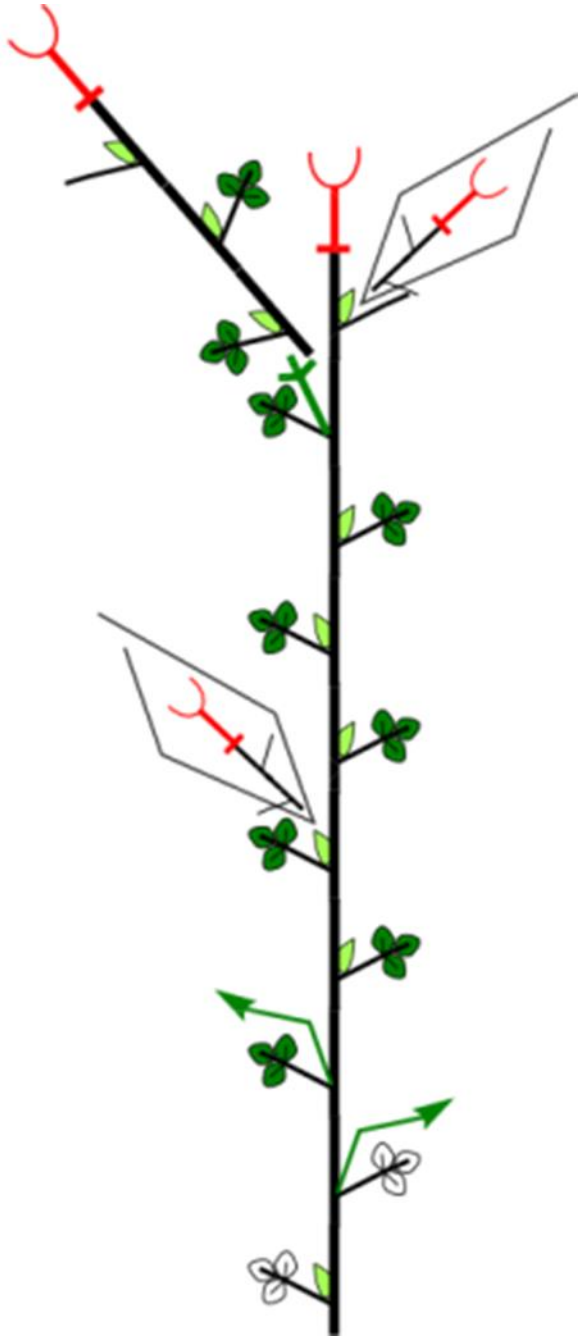
Expanded leaf with an axillary growing shoot (side crown)

Expanded leaf with an axillary flower bud

Expanded leaf with an axillary bud

Dead leaf with an axillary stolon

Dead leaf with an axillary bud

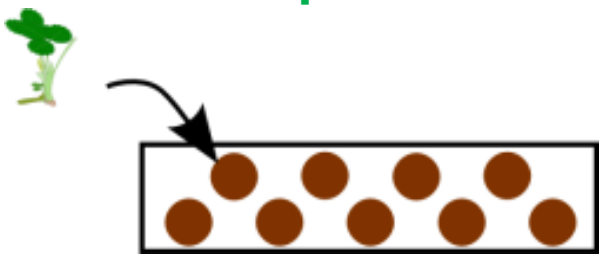


EFFECT OF DIFFERENT NURSERY TECHNIQUES

Materials and methods

Remontant cv (Capri)

Rooted tip runners

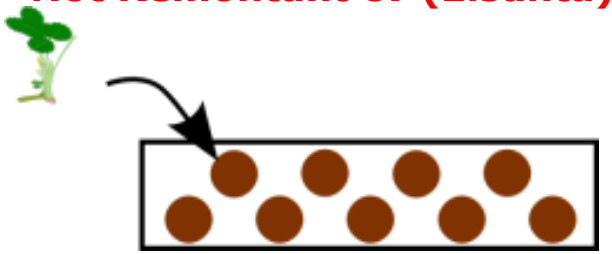


Tray

05 Aug 2012

W1 W2 W3 W4 → Plant analysis

Not Remontant cv (Elsanta)

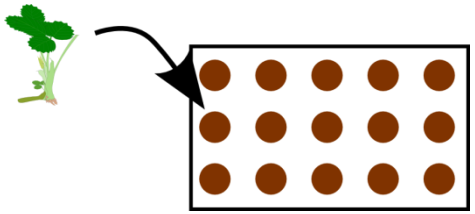


Tray

18 July 2012

W1 W2 W3 W4 W5 W6

W1 W2 W3 W4



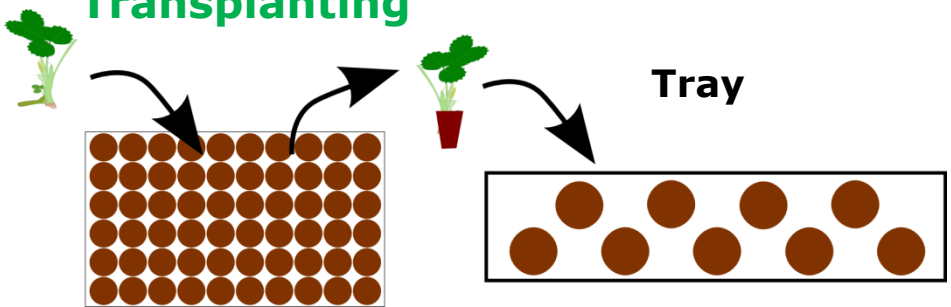
Minitray

W1 W2 W3 W4 W5 W6

30 July 2012

W1 W2 W3 W4 W5

Transplanting

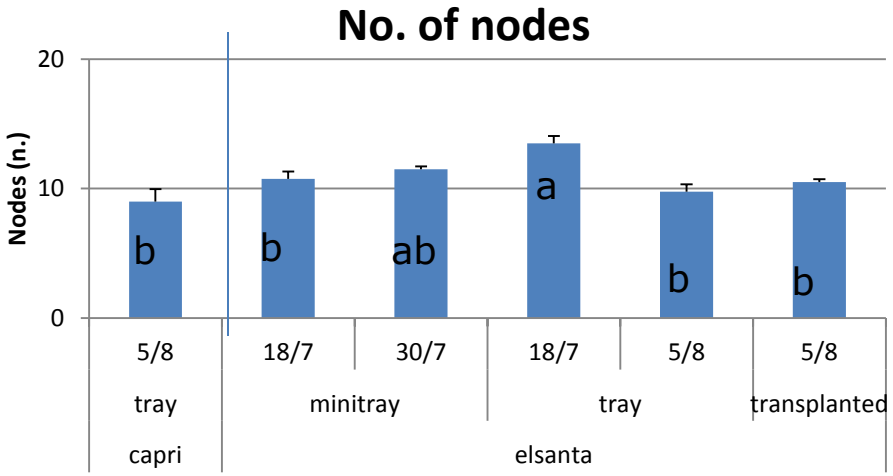


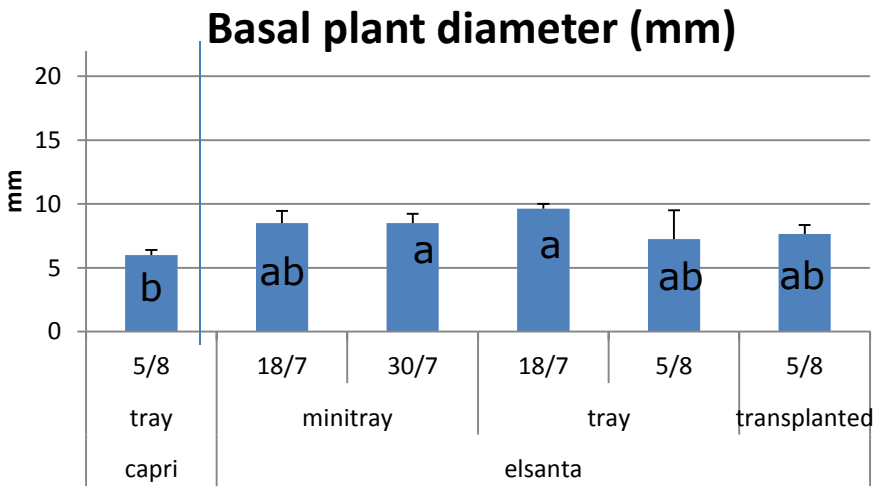
Tray

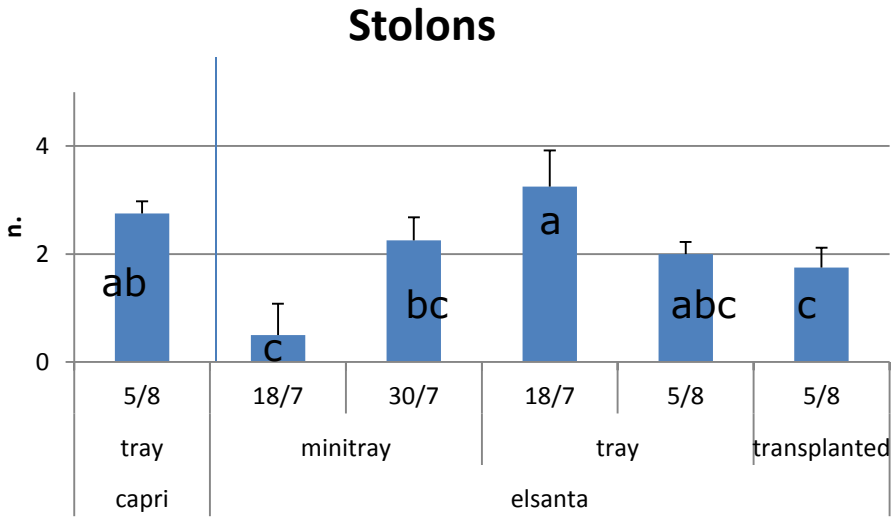
Transplanting

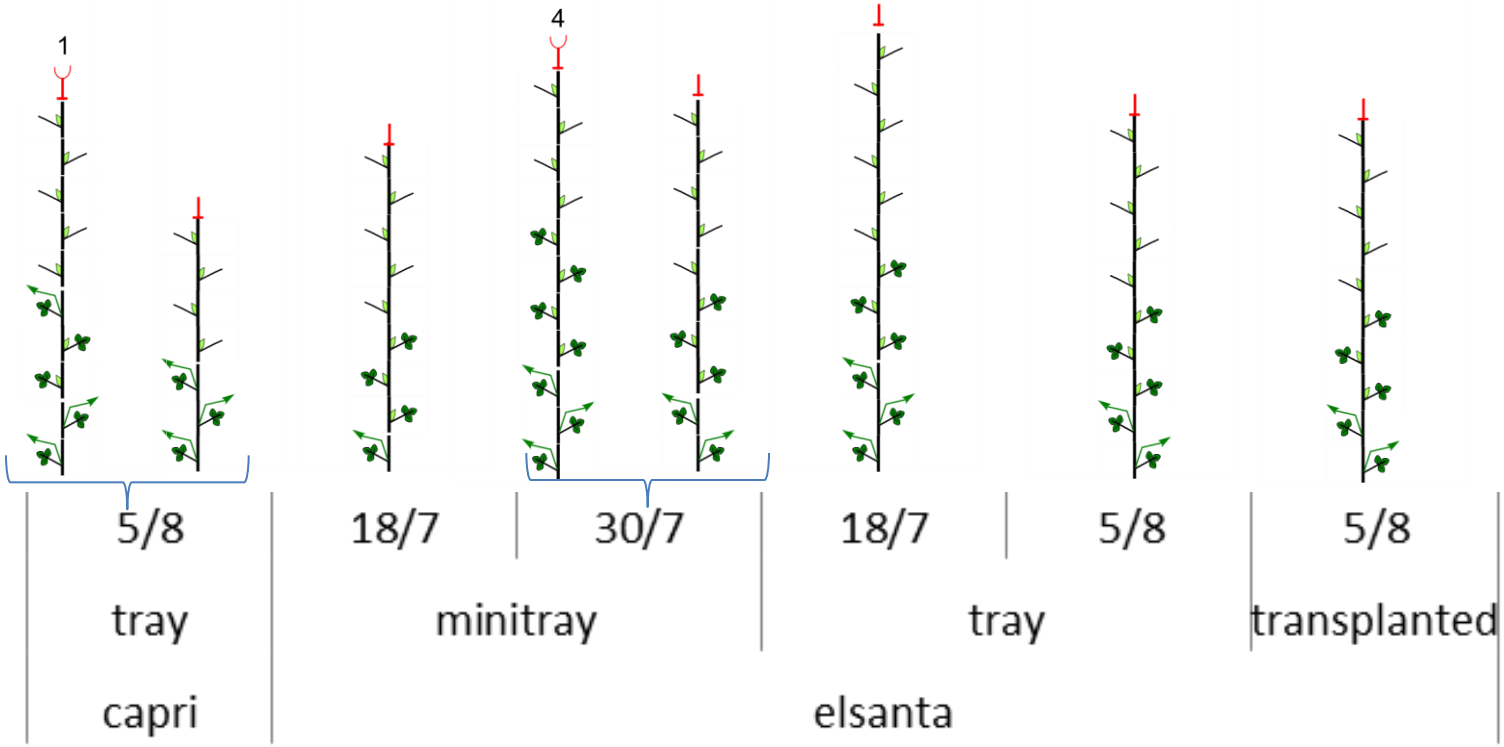
W1 W2 W3 W4

Beginning September 2012








1
4
5/8
18/7
30/7
18/7
5/8
5/8
tray
minitray
tray
transplanted
capri
elsanta

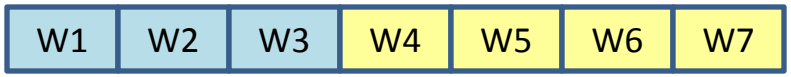
Not Remontant cv (Elsanta)

Tray Plants

30 July 2012

++ **Continuous fertigation**

-+ **Delayed fertigation** (2 farms)



-+ **Delayed fertigation**

MiniTray

05 Aug 2012

-+ **Delayed fertigation**

Fertigation

LOW EC Fertig.

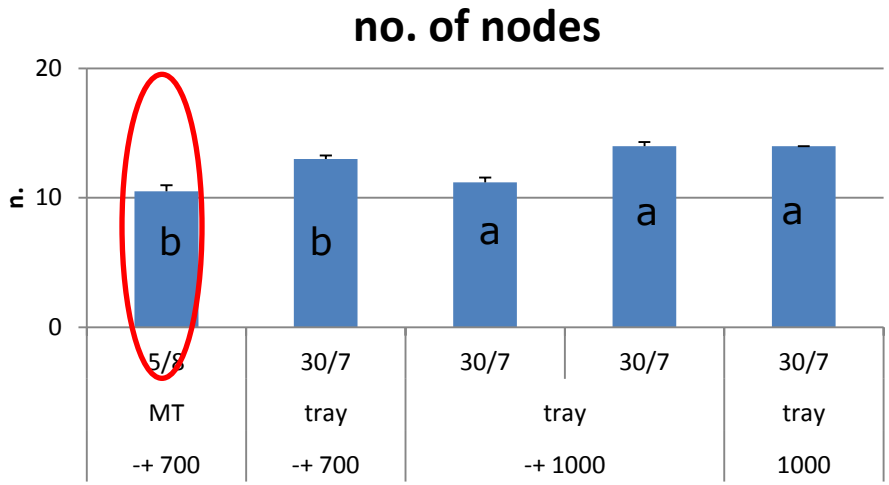
EC 1000 µS/cm

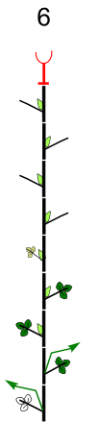
EC 700 µS/cm

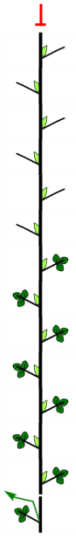
Irrigation

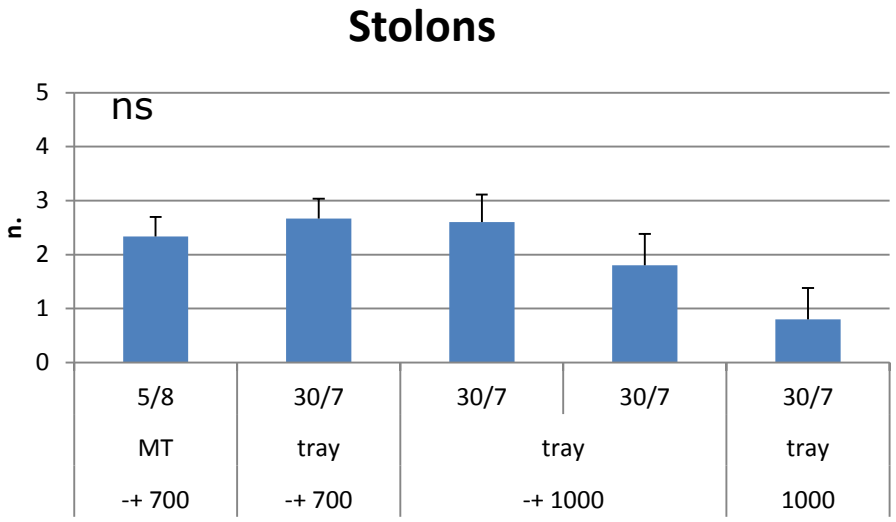
NO3	H2PO4	SO4	NH4	K	Ca	Mg	Fe	Mn	Zn	B	Cu	Mo
			mmol						umol			
5	1,8	1,5	0,6	3	4	2,35	20	20	8	12	1,75	0,75

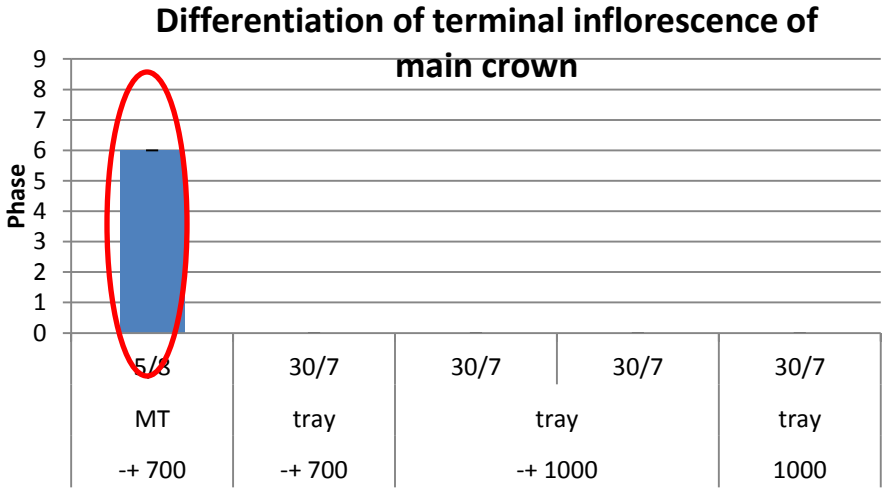
Beginning September 2012











Remontant cv (Capri): Tray Plants

05 Aug 2012

W1	W2	W3	W4	W5	W6	W7	W8	W9	++	Continuous fertigation
W1	W2	W3	W4	W5	W6	W7	W8	W9	-+	Delayed fertigation (2 farms)

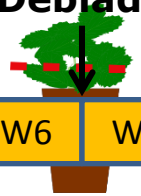
Not Remontant cv (Elsanta): MiniTray

W1	W2	W3	W4	W5	W6	W7	W8	W9	-+	Delayed fertigation

Not Remontant cv (Elsanta): Tray Plants

18 July 2012

Deblading



W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	-+	Delayed fertigation Debladed plants (2 farms)
W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	-+-	Temporary fertigation (2 farms)

Irrigation

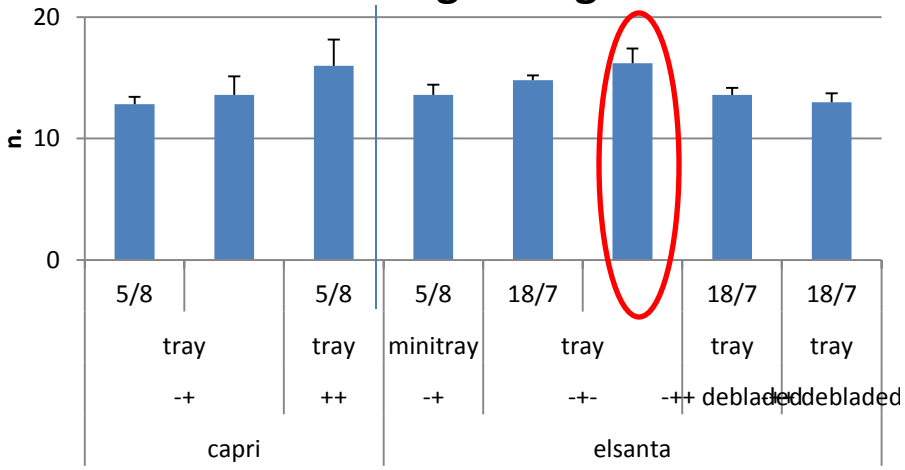
Fertigation

EC 1000 µS/cm

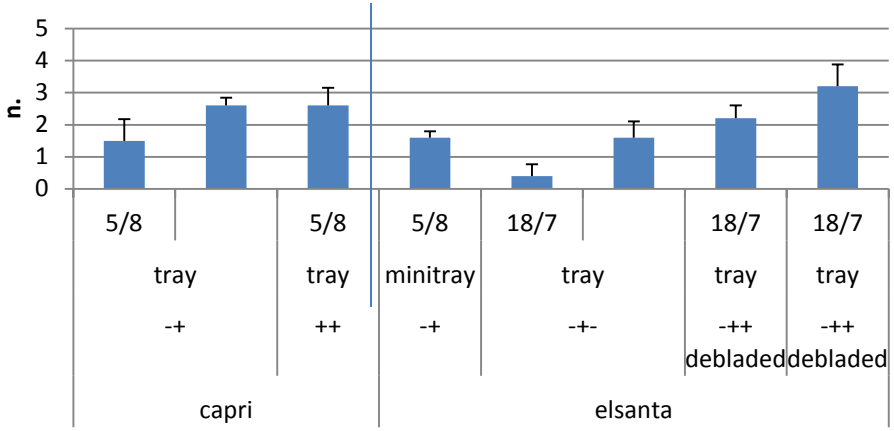
NO3	H2PO4	SO4	NH4	K	Ca	Mg	Fe	Mn	Zn	B	Cu	Mo
			mmol						umol			
5	1,8	1,5	0,6	3	4	2,35	20	20	8	12	1,75	0,75

Beginning October 2012

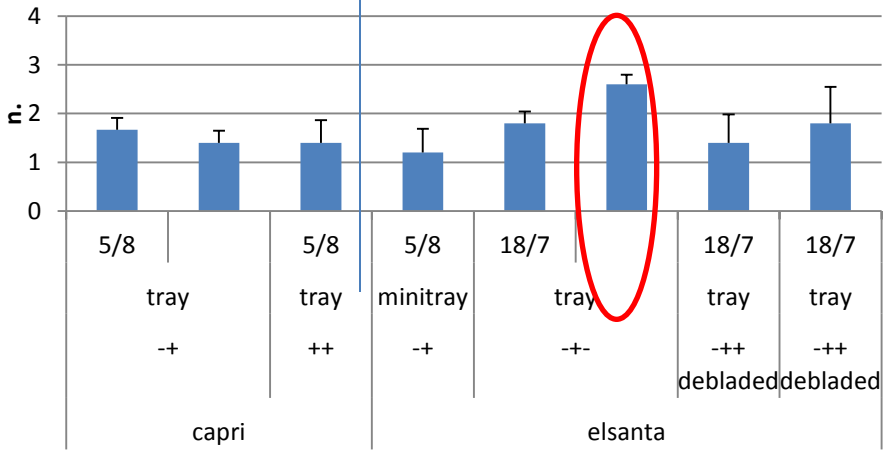
Total no. of growing nodes



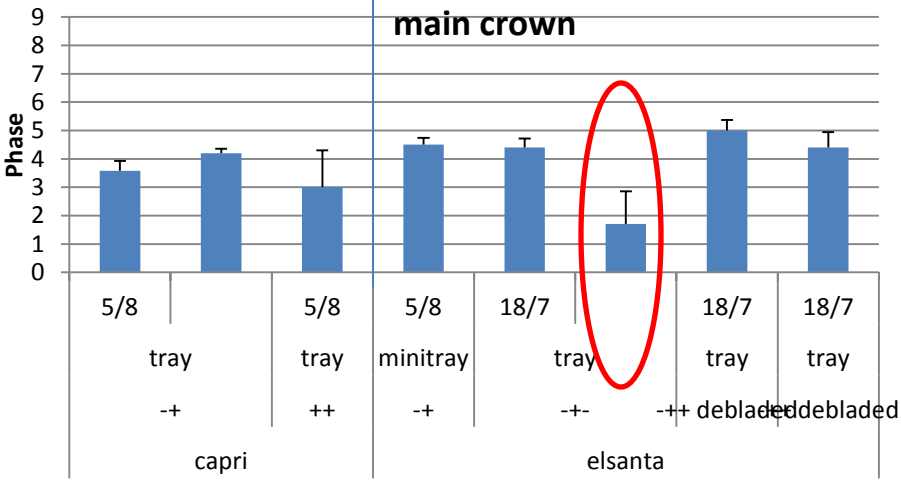
Stolons

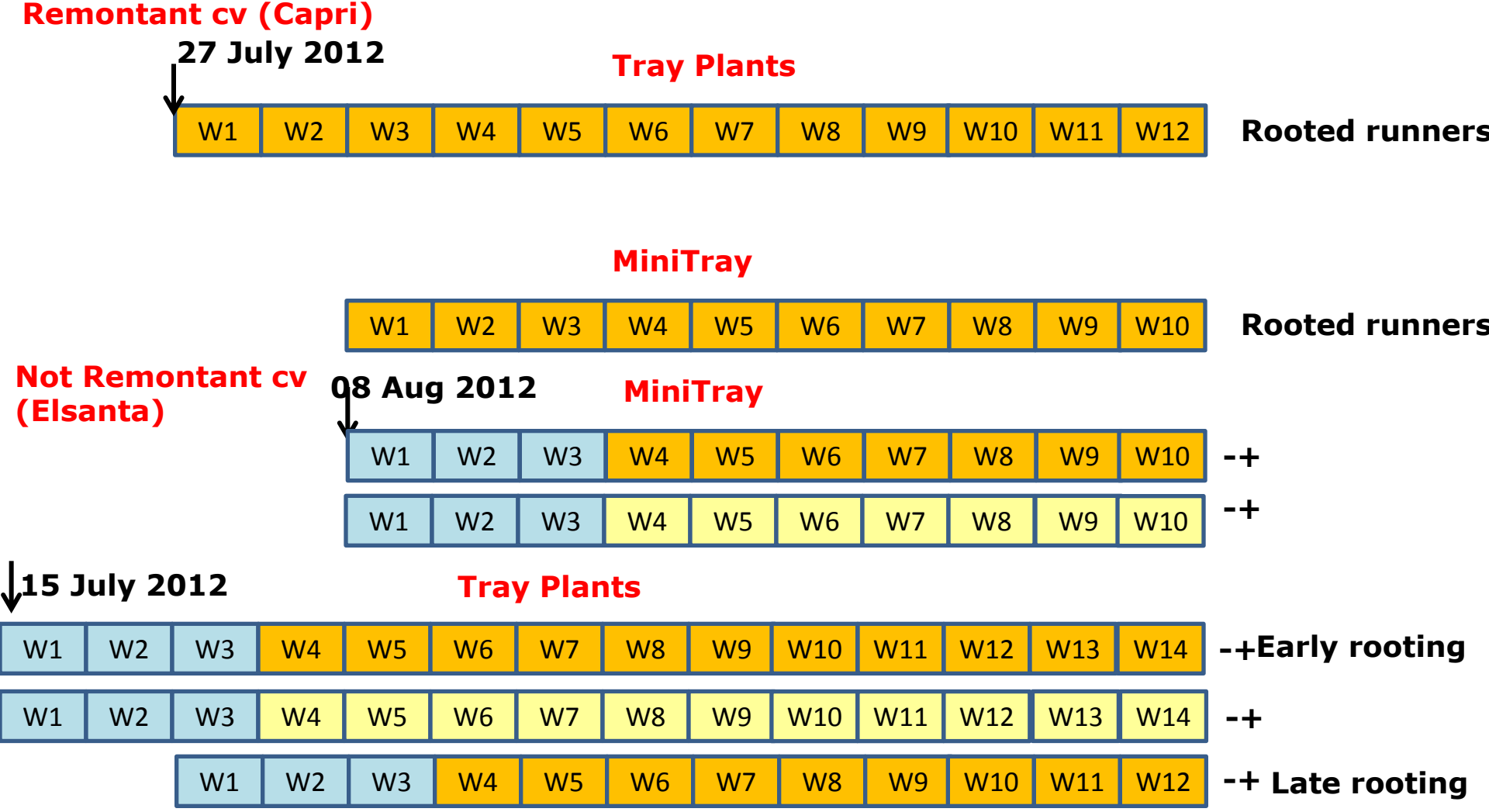


Total no. of inflorescences



Differentiation of terminal inflorescence of main crown





Fertigation

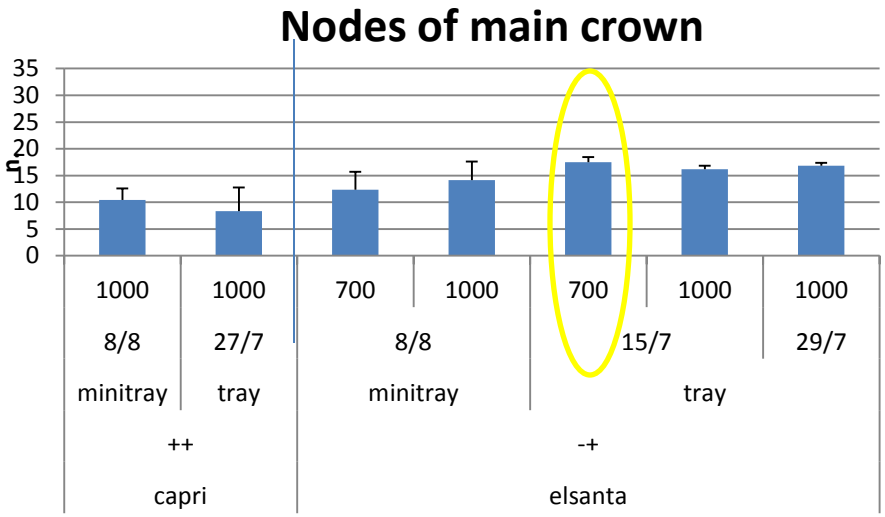
LOW EC Fertig.

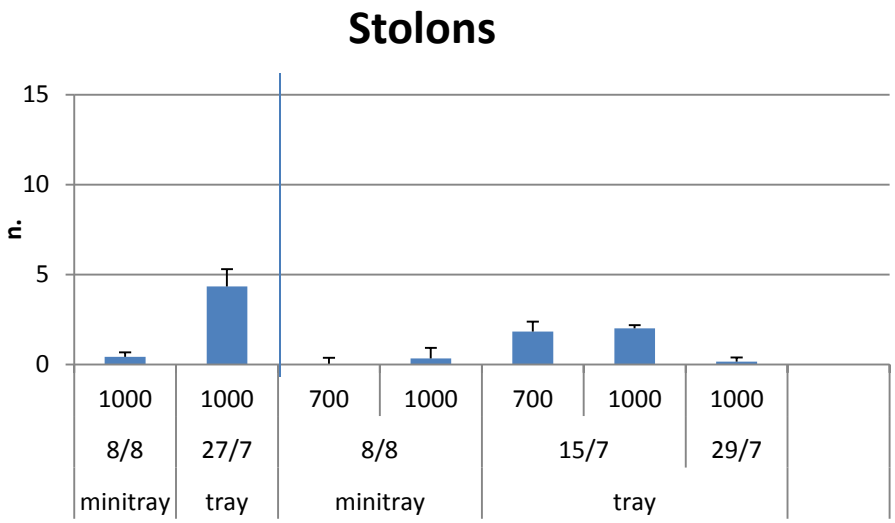
EC 1000 µS/cm

EC 700 µS/cm

Irrigation

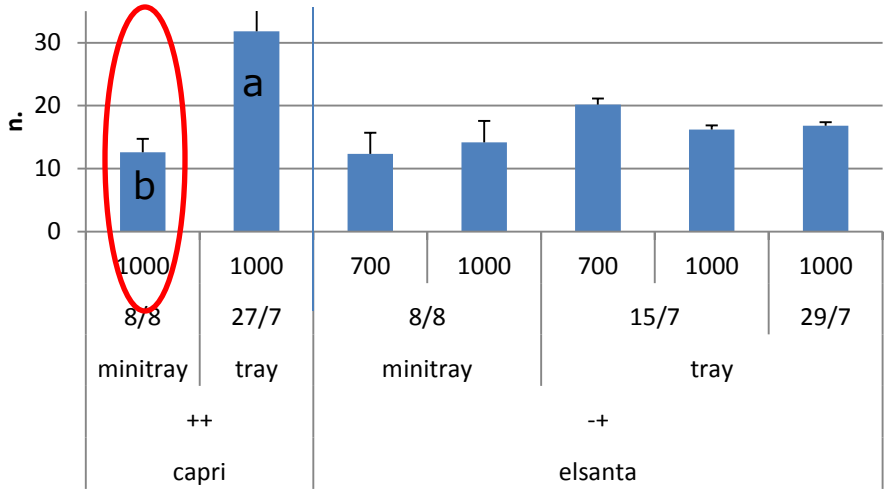
NO3	H2PO4	SO4	NH4	K	Ca	Mg	Fe	Mn	Zn	B	Cu	Mo
			mmol						umol			
5	1,8	1,5	0,6	3	4	2,35	20	20	8	12	1,75	0,75


Nodes of main crown
n.
35
30
25
20
15
10
5
0
1000
8/8
minitray
1000
27/7
tray
++
capri
700
1000
8/8
minitray
700
1000
15/7
tray
1000
29/7
tray
-+
elsanta

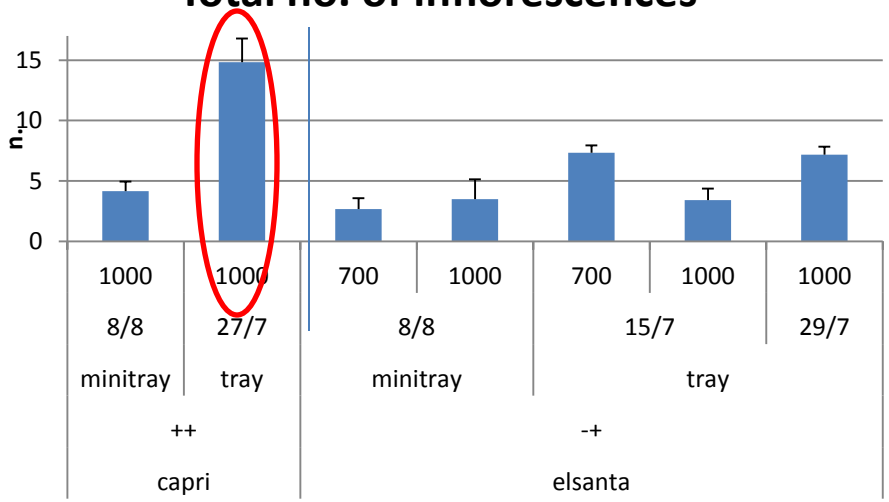

Stolons
n.
15
10
5
0
1000
8/8
minitray
1000
27/7
tray
700
1000
8/8
minitray
700
1000
15/7
tray
1000
29/7
tray

Late October 2012

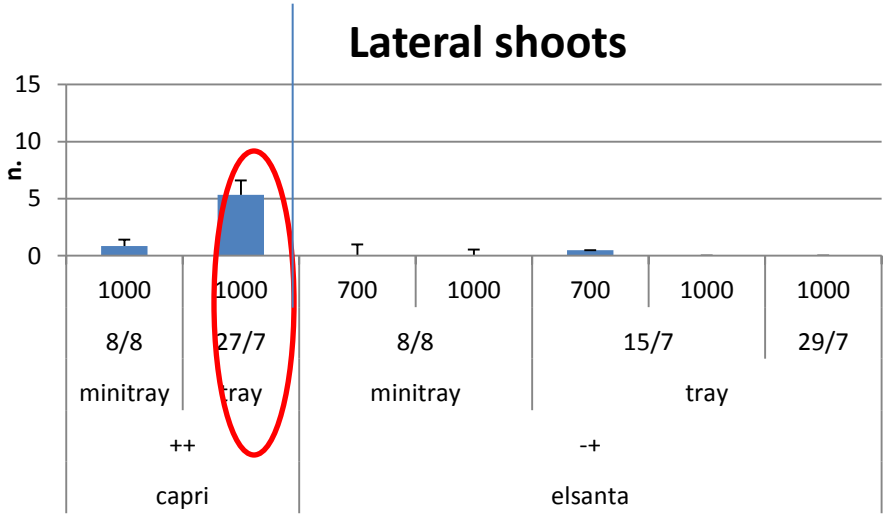
Total no. of growing nodes



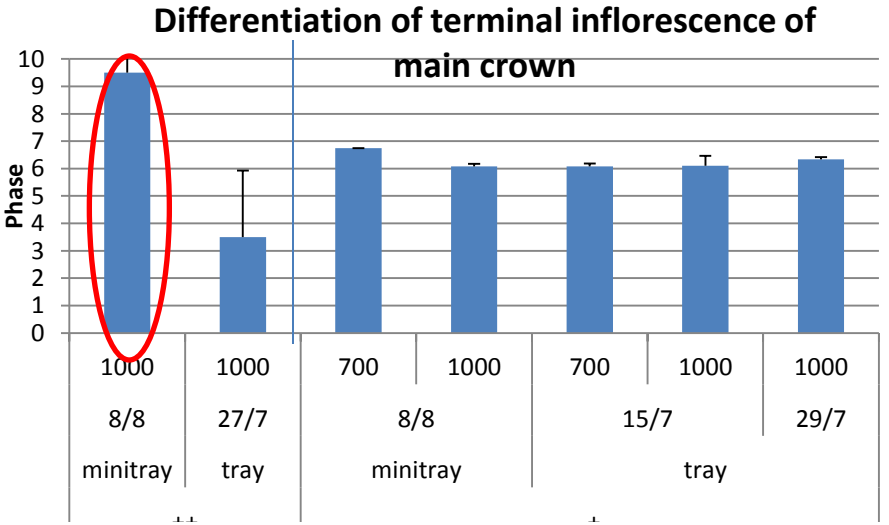
Total no. of inflorescences



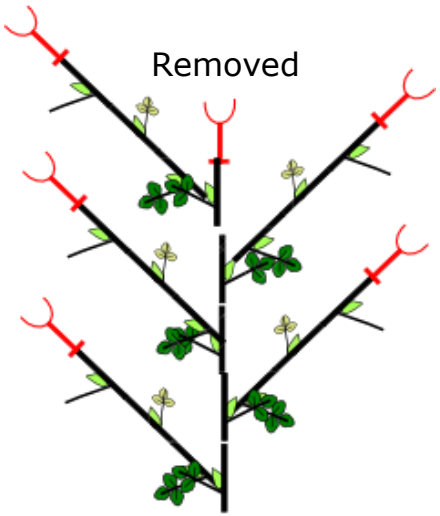
Lateral shoots

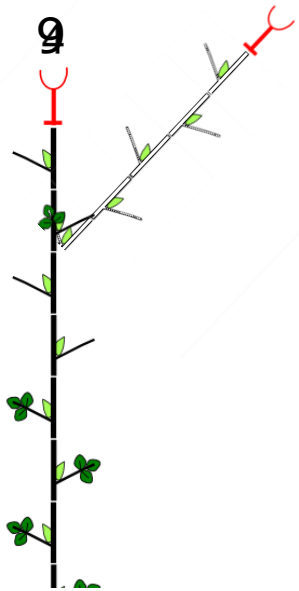


Differentiation of terminal inflorescence of main crown



Remontant cv (Capri)





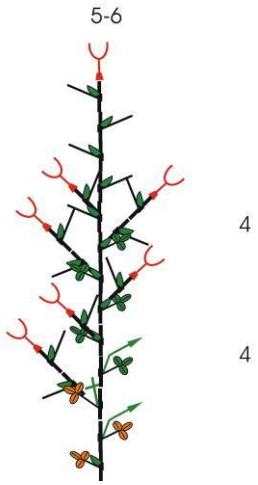
Not Remontant cv (Elsanta)

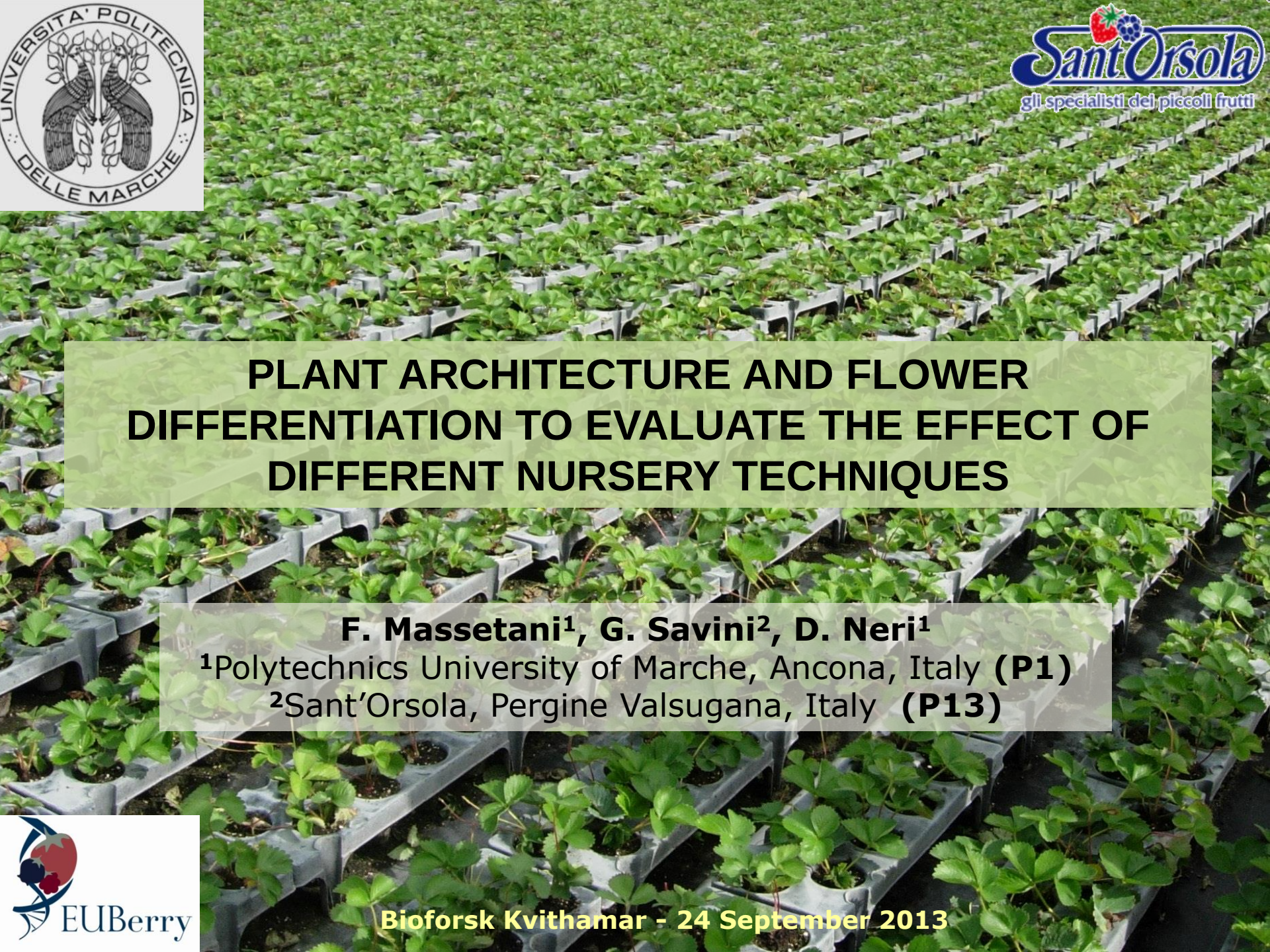
Tray plants

700 EC

1000 EC

1000 EC late rooting





PLANT ARCHITECTURE AND FLOWER DIFFERENTIATION TO EVALUATE THE EFFECT OF DIFFERENT NURSERY TECHNIQUES

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Bioforsk Kvithamar - 24 September 2013