DA Meter: Science and Practical use

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Supported by the WSU Tree Fruit Endowment

DA-meter…

- is an instrument developed by prof. Guglielmo Costa and co-workers, [University of Bologna, patent WO/2007/017732, (Noferini et al. 2006)];
- is a vis/NIR spectrometer portable and easy to use and calibrate;
- provides a new "non-destructive" index that allows to know the fruit ripening stage;
- This index represents the chlorophyll's content in a fruit that usually decreases in a climacteric fruit during maturity.

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DA-meter…

….is FIRSTLY a RESEARCH TOOL, but can be largely used in any stage of fruit production and chain:

- ❑ by a grower to try to optimize the fruit distibution in the tree in order to have a more homogeneous product and reduce the number of picking stage;
- ❑ by the grower, to monitor the fruit growth and ripening in order, to identify the best moment to pick;
- ❑ by packing house, to pre-select fruits before store them and estimate the shelf life according to the ripening stage of different fruit boxes/groups;
- ❑ by the retailer to decide which riper fruit should be sold before others;

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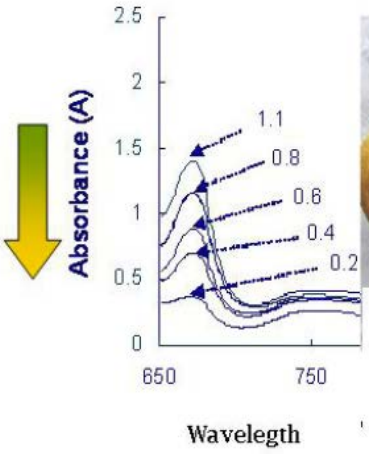
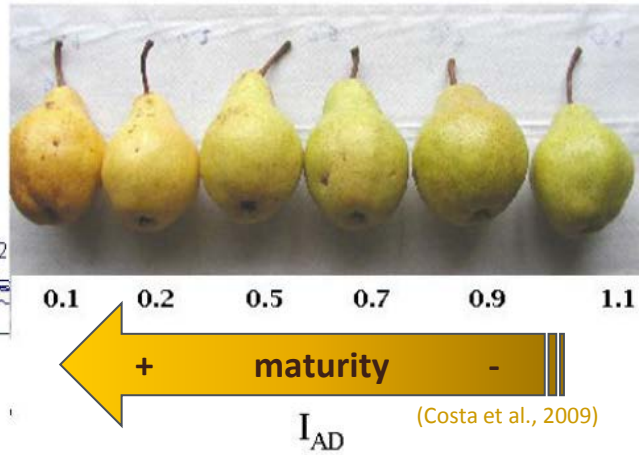
DA-meter… measures a new parameter called

Index of Absorbance Difference

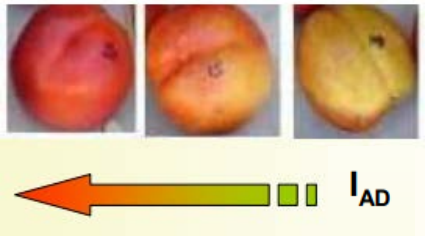
$(I_{AD}) = A_{670nm} - A_{720nm}$

- Difference in absorbance between 2 precise wavelengths: 670 nm (near the Chl-a absorption peak) and 720 nm (background of the spectrum).
- I_{AD} is related to the **actual content of Chl-a in the fruit mesocarp** and to ethylene evolution during on-tree ripening *(Ziosi et al; 2008).*
- Is formed by 6 diode LEDs (3 diode emit at 670 nm and 3 at 720 nm) placed around the photodiode detector.
- Fruit is illuminated alternatively by the 2 monochromatic sources of light and the index represents the amount of light re-emitted by the fruit.
- Light detected by the photodiode is converted in a digital signal by ADC and a microcontroller provides the index.





(Costa et al., 2009)



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DA-meter…

correlation (R^2 = 0.979) between the I_{AD} and the Chl-a content in fruit outer mesocarp: decreasing values of the index with decreasing amounts of pigment at ripening.

Available online at www.sciencedirect.com
ScienceDirect
Postharvest Biology and Technology 49 (2008) 319–329
Postharvest Biology and Technology
www.elsevier.com/locate/postharvbio

A new index based on vis spectroscopy to characterize the progression of ripening in peach fruit

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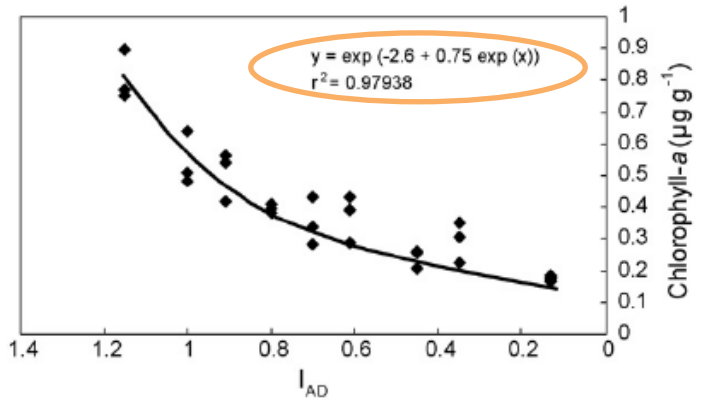

Fig. 2. Correlation between I_{AD} and chlorophyll-*a* amount in outer mesocarp of 'Stark Red Gold' nectarines. Solid line represents the best-fit function.

- Developed originally for peach, it works also on pears and apples.
- Similar devices have been developed for cherry (Cherry meter) and for kiwi (kiwi-meter).

This index can be really useful to grade fruit into different ripening classes from harvest to cold storage.

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Experimentation on peach and DA meter

Determination of organoleptic and nutraceutical properties of peach fruit: role of metabolism of phenylpropanoids and phenolic compounds.

Quality analysis on fruit in different ripening stages

CV	stage	I_{AD} class	Weight (g)	Diameter (mm)	Firmenss (kg/cm^2)	Firmness (N)	°Brix	pH	Acidity
Spring Crest	Pre-climacteric 14 June (80 DAFB)	0,70-0,79	65,90	49,88	4,76	46,71	8,90	3,38	8,62
	Climacteric 21 June (87 DAFB)	0,40-0,59	68,07	50,12	4,24	41,53	8,84	3,47	7,86
		0,20-0,39	78,47	53,56	3,68	36,13	8,94	3,48	7,68
		<0,20	81,03	54,58	1,97	19,32	9,74	3,59	6,41
	Post-climacteric 25 June (91 DAFB)	0,05-0,1	56,23	89,36	0,77	7,51	9,50	3,74	5,33
		<0,05	56,40	89,97	0,40	3,88	9,52	3,78	4,39

Example of the results of the qualitative analyses on Spring Crest,

the main quality parameters are consistent with the trend of maturation and proportional to the performance of I_{AD}.

Experimentation on apple and DA meter

Optimization of MODI'®CIVG198 orchard management

Fruiting *habitus* investigation

- Two picking times about 7 days from each other .
- Three canopy levels: < 0.8m = low, 0.8-1.8m = medium, >1.8m = high

high

middle

low

Spurs on axis

Brindle-type shoots

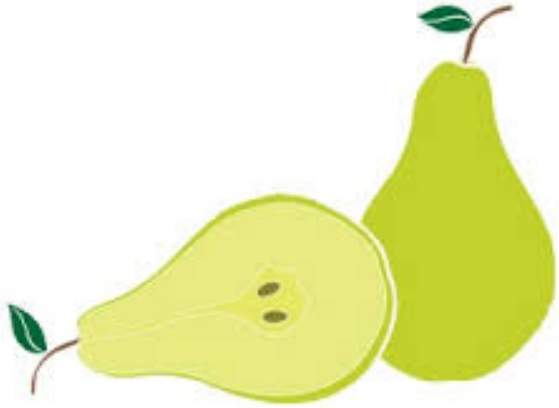
Spur on 1-year-old shoot

Spur on 2-years-old and over braches

Optimization of MODI'®CIVG198 orchard management

Qualitative parameters farm T (2011)

Training system	Picking time	Average fruit weight (g)		Ratio H/W		DA index		Overcolour %		Russeting %		SSR °Brix		Firmness (Kg/cm^2)		pH		Acidity (g/l malic acid)		Starch index (1-10)		White haze %
Bi-axis	1st	191	a	1.03	a	0.55		72.65	b	1.72	a	13.32		6.66	b	3.81		3.41		9.47		71.6
	2nd	174	b	0.99	b	0.55		76.19	a	0.94	b	12.54		6.92	a	3.59		3.67		9.34		61.3
	Significance	***		***		*ns*		*ns*		***				**						*ns*		
Spindle	1st	182	a	0.99	a	0.60		77.10	b	2.15	a	13.55	a	6.99		3.86	a	3.14	b	9.32		72.8
	2nd	169	b	0.97	b	0.63		86.04	a	1.33	b	12.98	b	6.98		3.59	b	3.71	a	9.19		57.3
	Significance	***		*		*ns*		***		***		**		*ns*		***		***		*ns*		
	Canopy level																					
Bi-axis	High	181		1.00	a	0.61	a	77.84	a	1.45		12.98		6.98	a	3.67	b	3.50		9.45		64.9
	Low	184		1.02	a	0.49	b	71.49	b	1.23		12.96		6.63	b	3.75	a	3.55		9.37		67.8
	Significance	*ns*		*		**		**		*ns*		*ns*		***		***		*ns*		*ns*		
Int. picking time*canopy level		*ns*		*ns*		***		**		**		*ns*		*ns*		*		*ns*		*ns*		
Spindle	High	175		0.97		0.72	a	83.44		2.01	a	13.24		7.07		3.70	b	3.50		9.03	b	57.8
	Low	174		0.98		0.51	b	80.40		1.39	b	13.29		6.89		3.76	a	3.35		9.48	a	71.3
	Significance	*ns*		*ns*		***		*ns*		*		*ns*		*ns*		*		*ns*		***		
Int. picking time*canopy level		*ns*		*ns*		*ns*		*ns*		*ns*		*ns*		**		*		*ns*		*ns*		



Experimentation on pear and DA meter

Aim of the experiment:

The aim of this study was to evaluate fruit quality and storability in relation to the different training systems, rootstocks and fruiting woods.

Evaluate the post harvest life of the fruit belonging to different maturity classes.

For this purpose we also utilized a recent non-destructive device called DA-meter that provides an index (I_{AD}) related to the chlorophyll degradation in the flesh and is well correlated with the level of ripening.

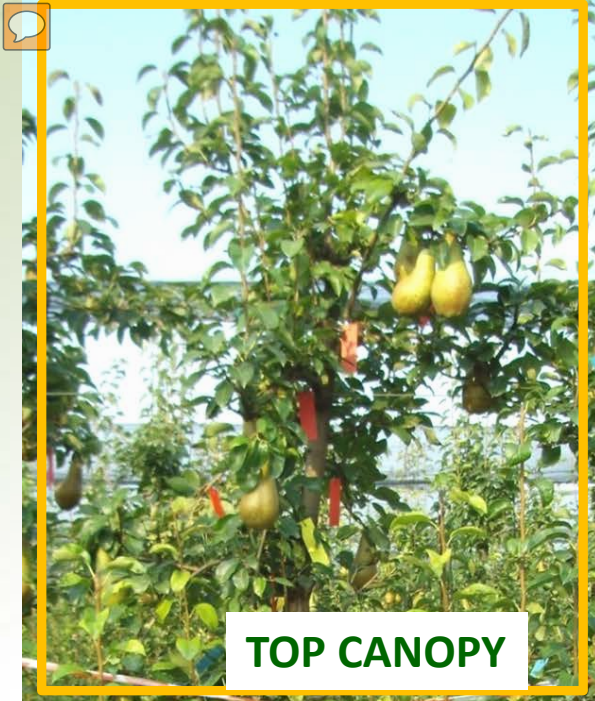

Same maturity???
?
Same storability???
Same quality???

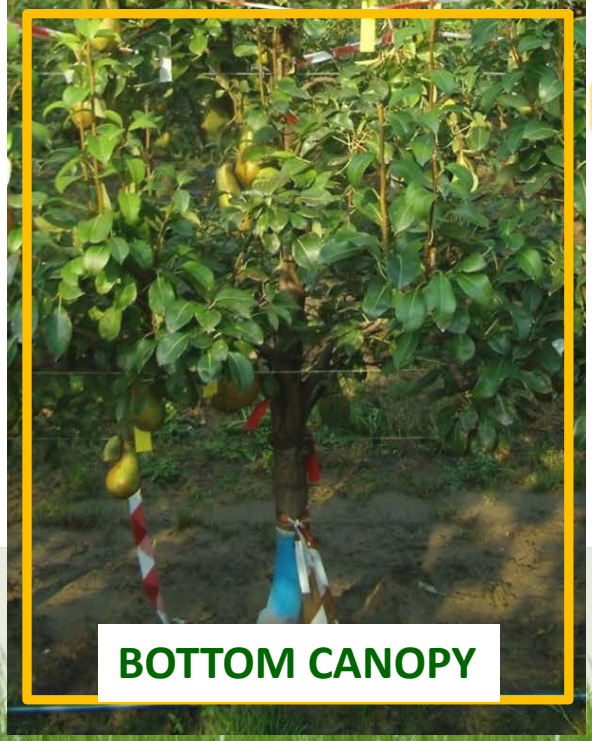
Materials and Methods

Experimental farm:
Fondazione “Fratelli Navarra” (Ferrara)
Year of planting 2005

Training system	Rootstock	Planting distance (m)	Planting densities (tree/ha)	Planting densities (tree/acre)
V	Sydo®	3.8 x 0.5	5,263	2,130
Spindle	Sydo®	3.3 x 0.8	3,787	1,534
Spindle	Adams	3.3 x 0.8	3,787	1,534
Spindle	MH®	3.3 x 0.8	3,787	1,534
Bi-axis	Sydo®	3.3 x 1.0	3,030	1,227

Materials and Methods

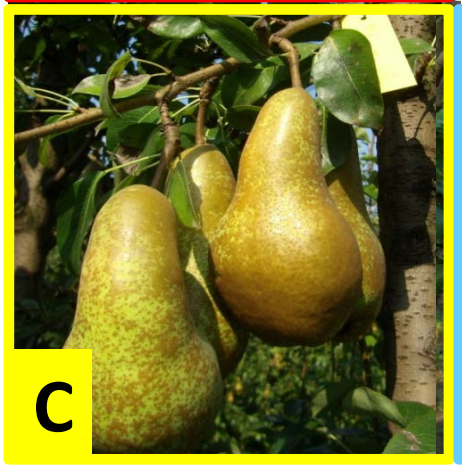




Canopy position:

top >1.4 m

bottom <1.4 m



Types of bearing wood:

A) BRANCHES 3 (and over) YEARS OLD

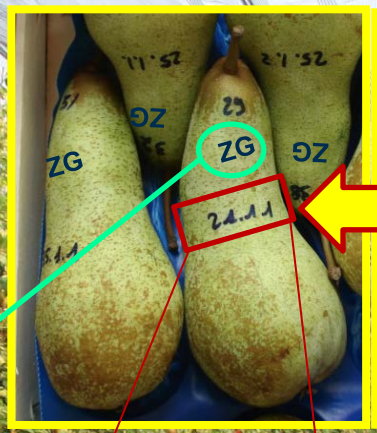
B) SHORT OLD SPURS

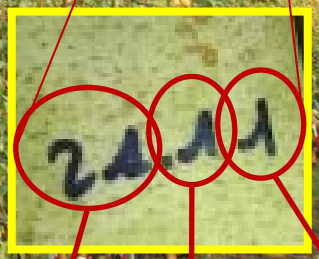
C) 2-YEAR-OLD BRANCHES

D) BRINDLE-TYPE SHOOTS (twigs)

Method of picking and classification

Harvest 2012: we picked fruits according to their position in the canopy, bearing wood, and position/wood combination. Each bearing wood that held a fruit was labeled in order to be able to sample it in the winter for the starch analysis and relate this with the qualitative fruit parameters.





progressive number of each type of wood selected along the row

number of fruit borne on that spur.

number of the bearing spur identified within that branch (ribbon)

5 combinations

x

4 bearing woods

x

2 canopy positions

x

100 fruit=

>4000 fruit

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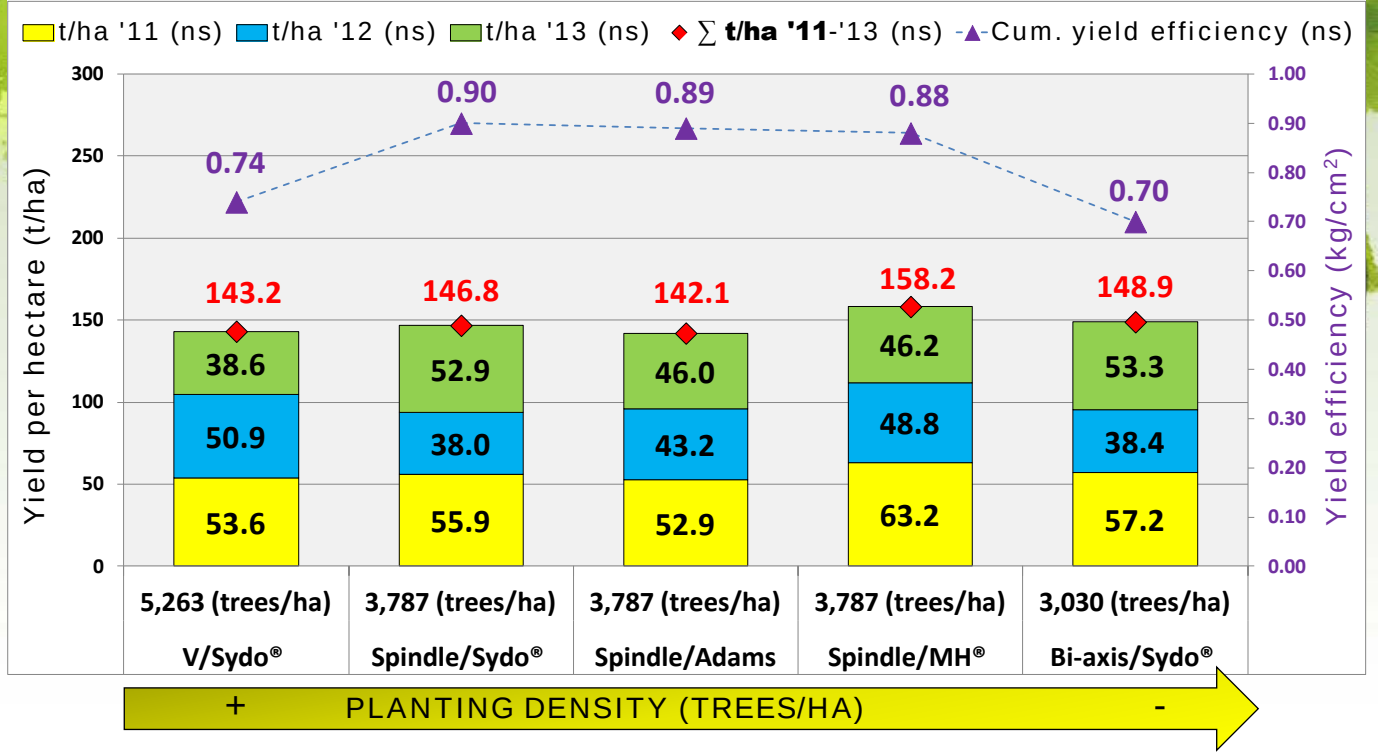
SPINDLE/SYDO top position in the canopy (≈100 frt)				
Bearing woods	**I_{AD} classes**	**qualitative analyses**		
2-yr-old branches	**<1.8**	T0		
	1.80-1.89	T0		
	1.90-1.99	T0	Td	Tm
	2.0-2.09	T0	Td	Tm
	>2.1	T0	Td	Tm
3-yr-old branches	**<1.8**	T0		
	1.80-1.89	T0		
	1.90-1.99	T0	Td	Tm
	2.0-2.09	T0	Td	Tm
	>2.1	T0	Td	Tm
Brindle-type shoots	**<1.8**	T0		
	1.80-1.89	T0		
	1.90-1.99	T0		Tm
	2.0-2.09	T0	Td	Tm
	>2.1	T0	Td	Tm
Short old spurs ★	**<1.8**	T0		
	1.80-1.89	T0		
	1.90-1.99	T0		Tm
	2.0-2.09	T0	Td	Tm
	>2.1	T0	Td	Tm

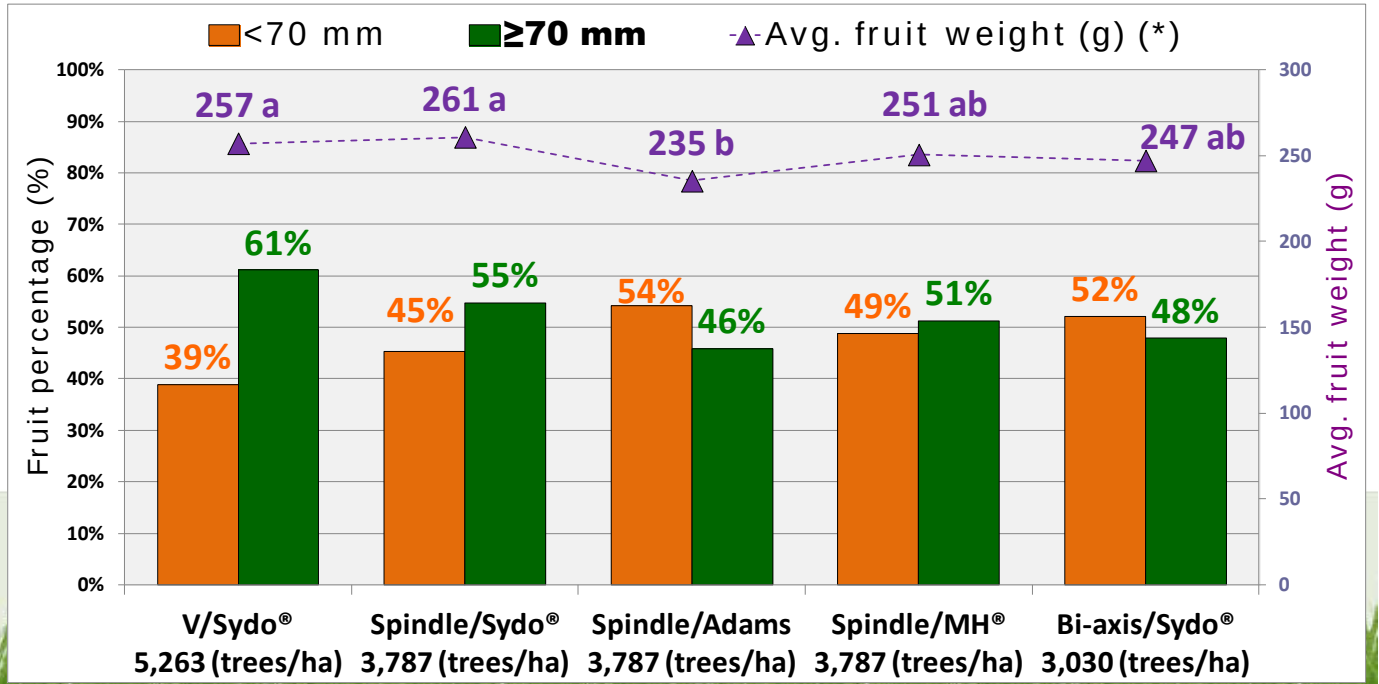
T0 fruit were analysed immediately after harvest (Sep)

Td e Tm were analysed monthly and destroyed in December and March respectively (3 M and >6 M at -1°C).

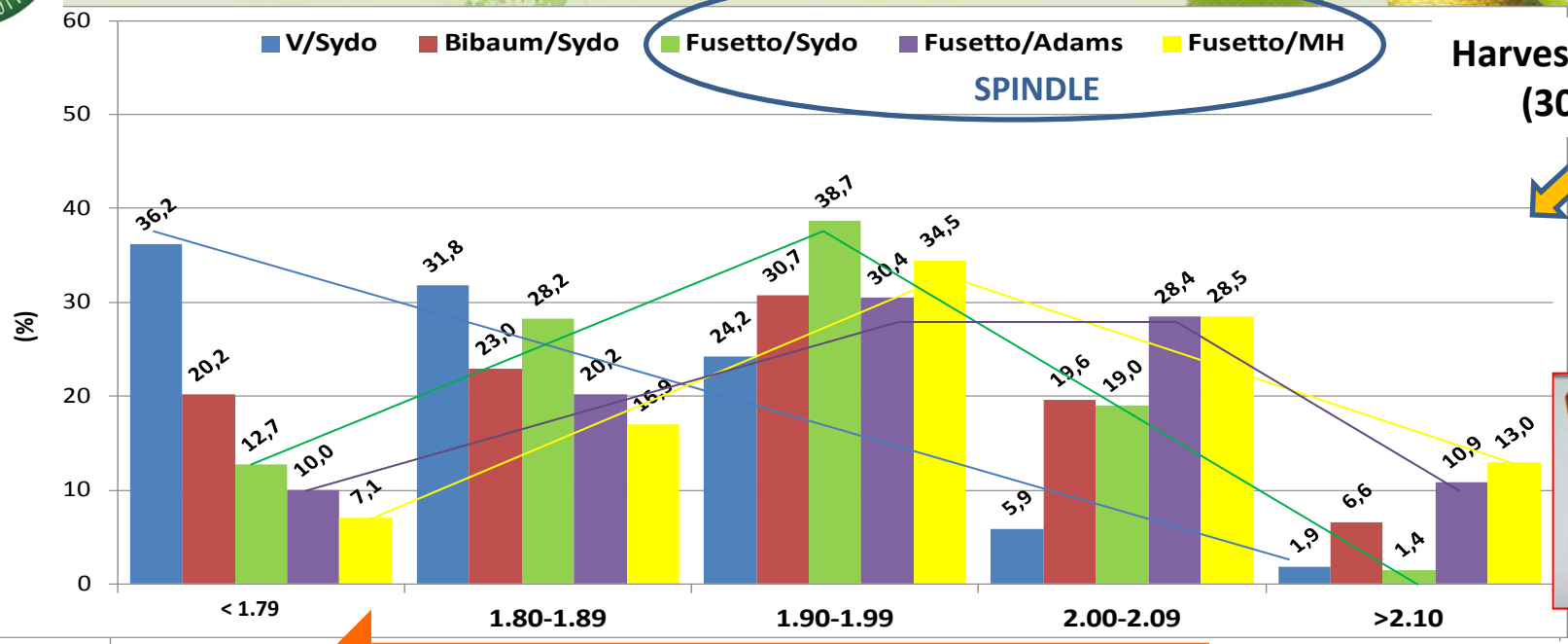
Yield per hectare from 2011 to 2013 and cumulative yield efficiency in 2013.



Fruit percentage (%) in two classes of size **(<70 and ≥70 mm)** and fruit weight, as averaged over 3 years (2011-2013).

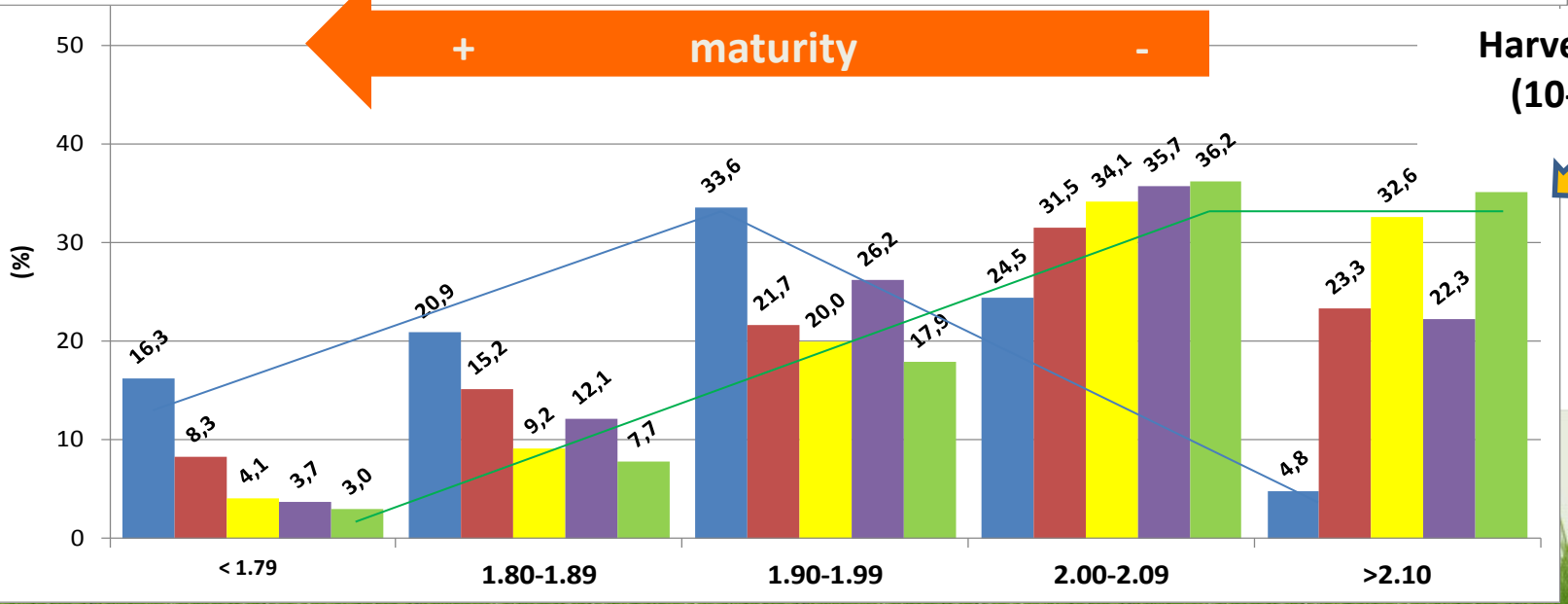


Difference among training systems: Fruit distribution in I_{DA} classes at harvest



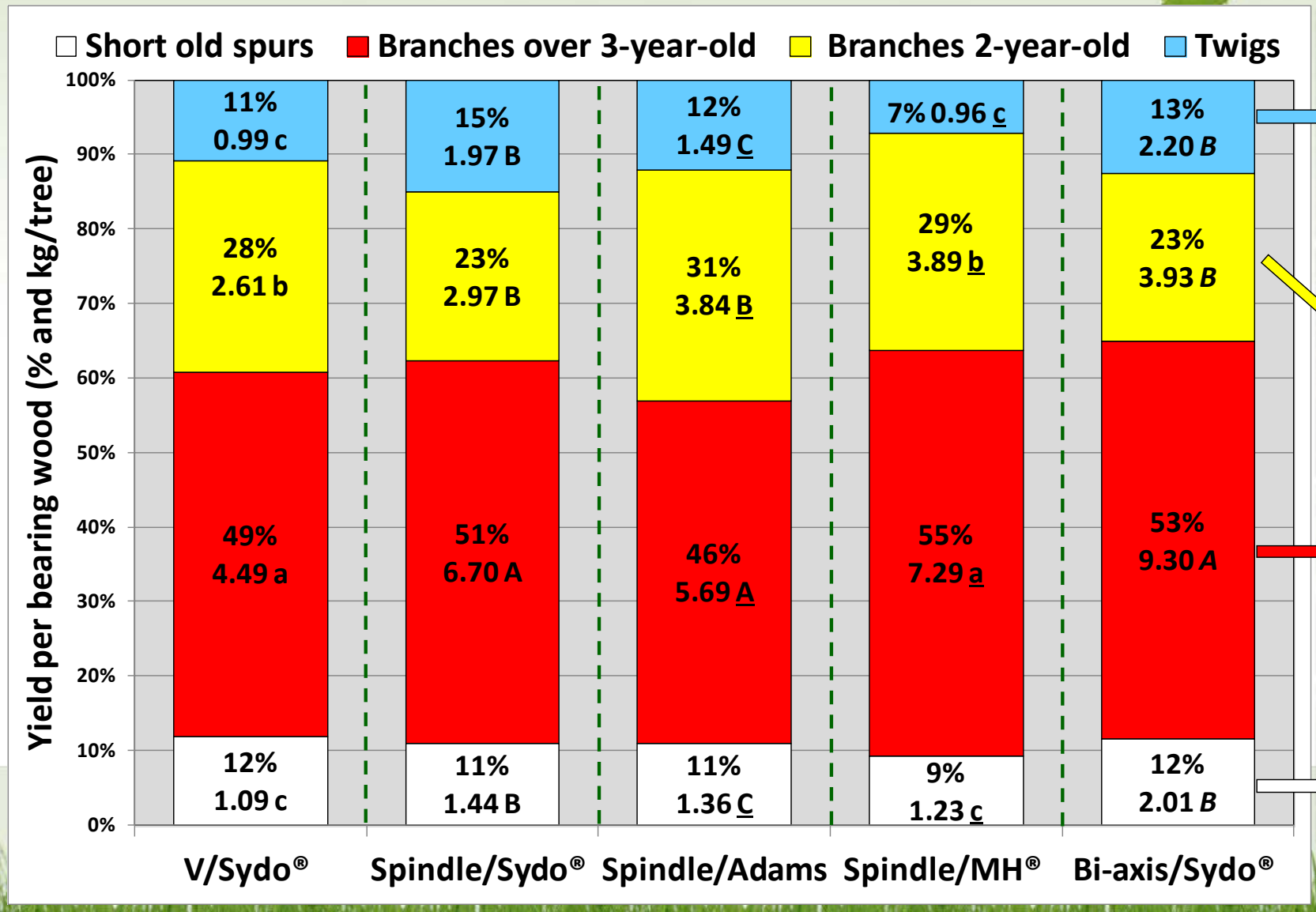
Harvest 2011 (30-31/8)

+ maturity -

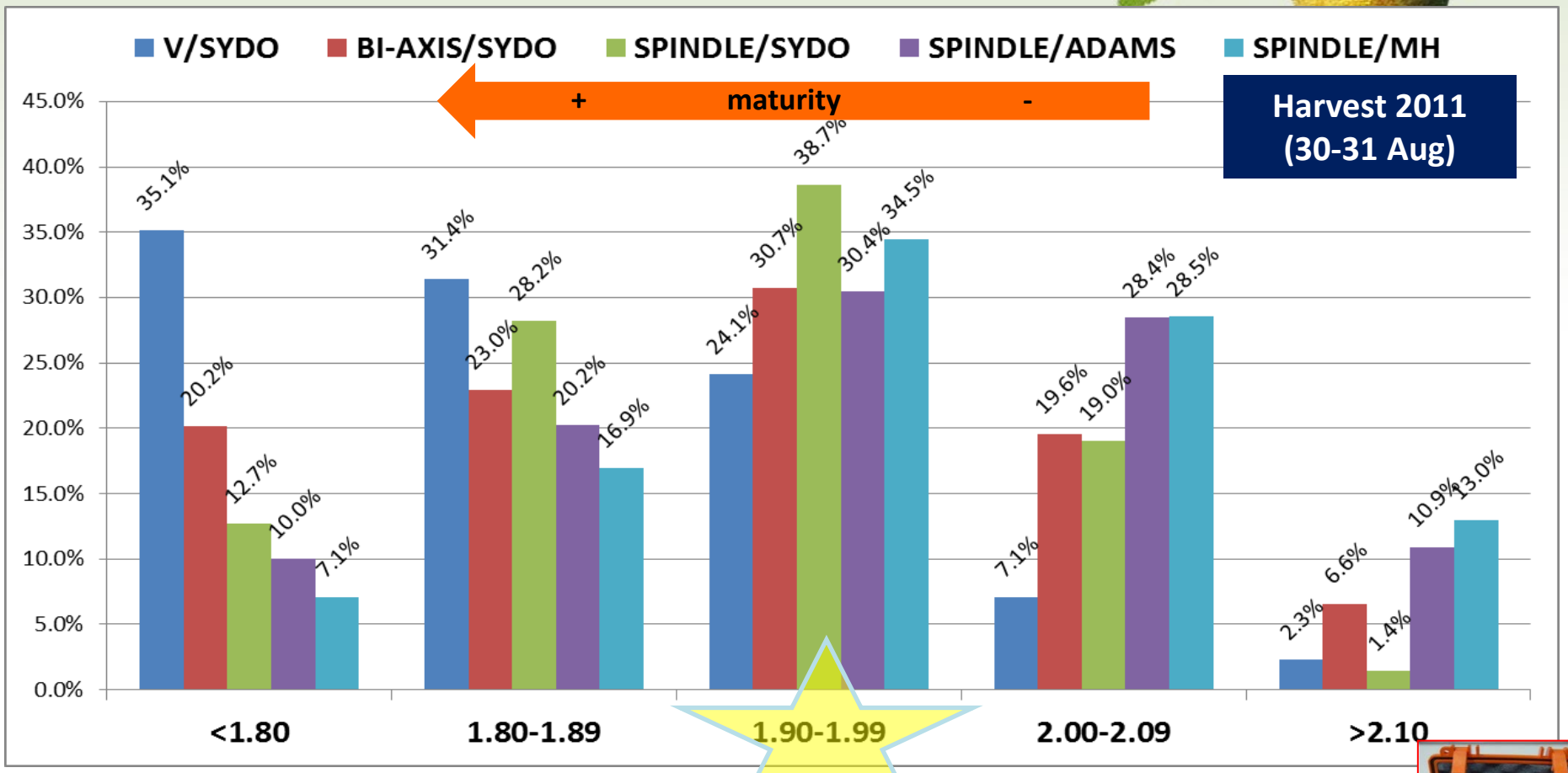


Harvest 2012 (10-11/9)

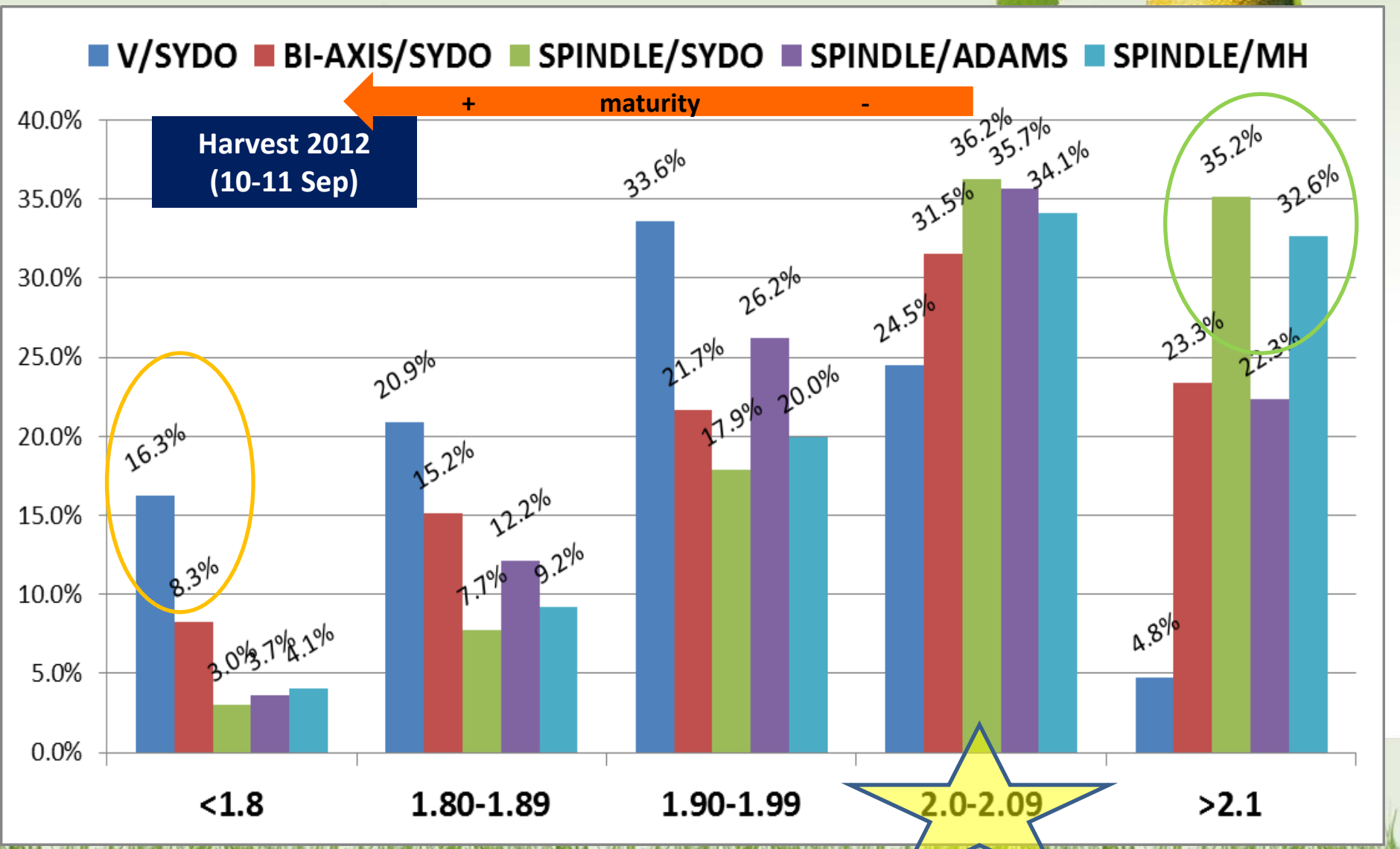
Yield per type of bearing wood (% and kg/tree) Averaged over 3 years (2011-2013).



Fruit distribution in I_{DA} classes at harvest

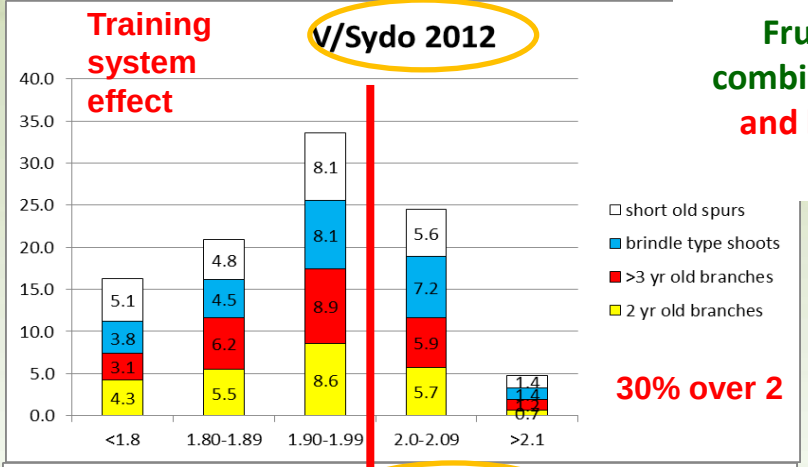


Fruit distribution in I_{DA} classes at harvest per combination

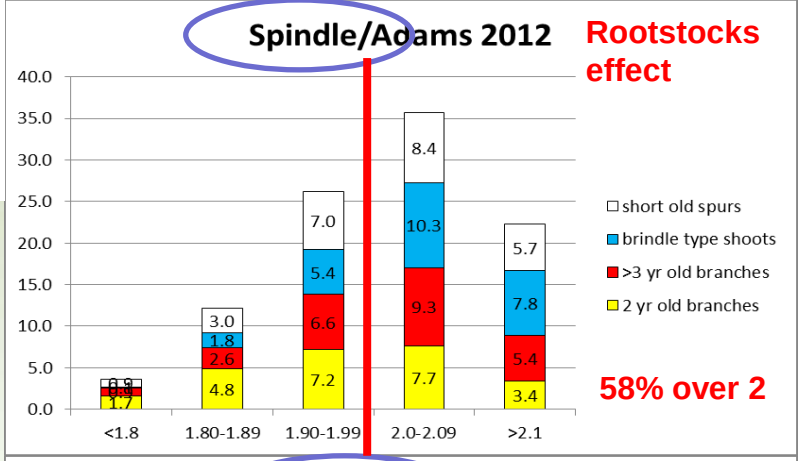


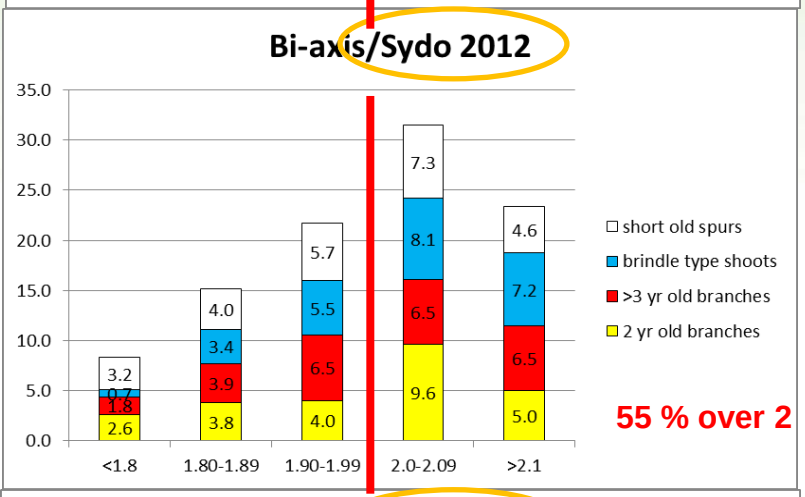
Fruit distribution: combinations I_{DA} classes and bearing wood at harvest

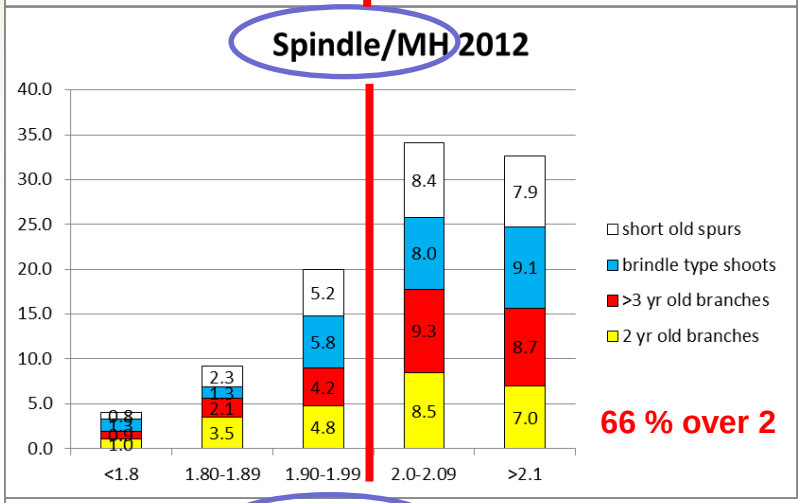
Training system effect

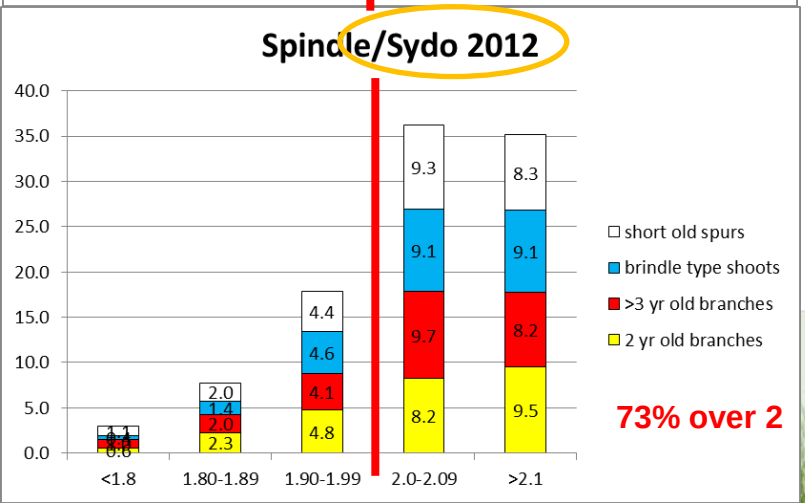


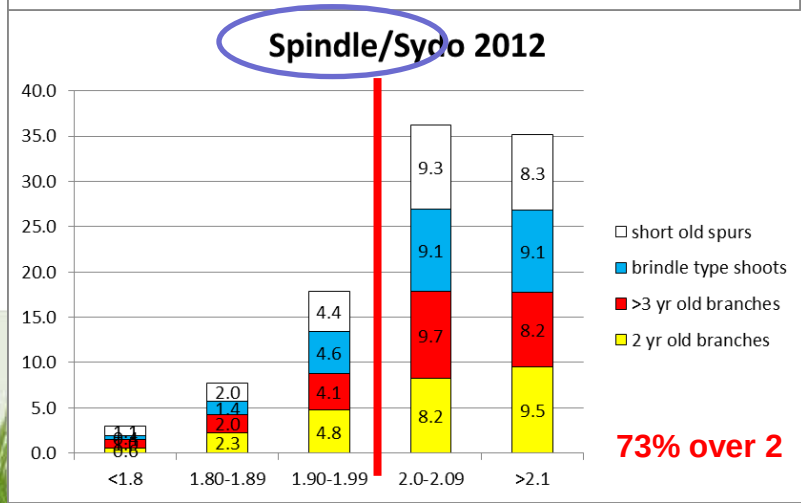
Rootstocks effect











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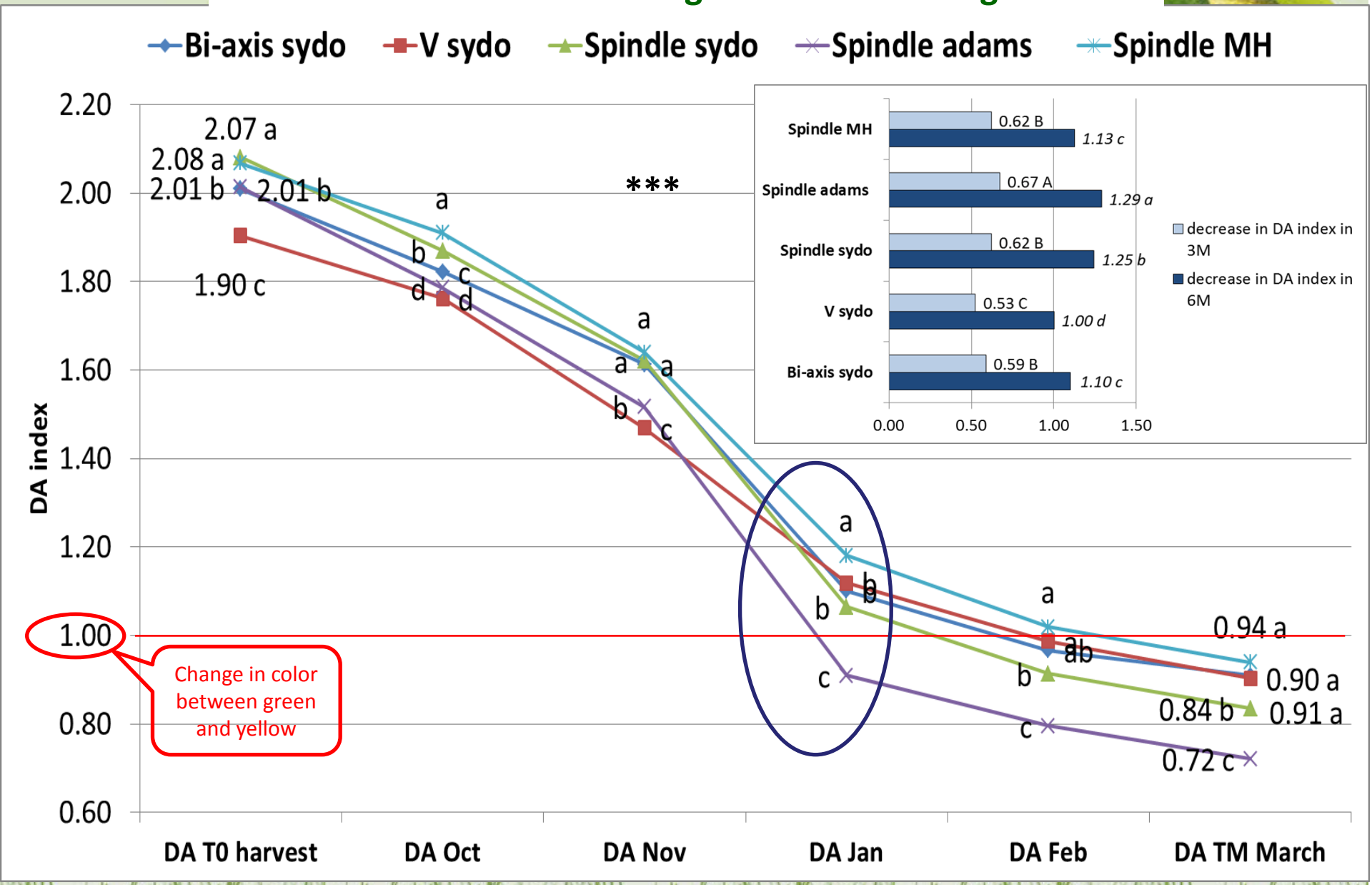
Angelys fruit's classification in I_{AD} classes according to original bearing wood.
First pick (T1= October 4th)

Different wood = different distribution of fruits.
We selected fruit from twigs

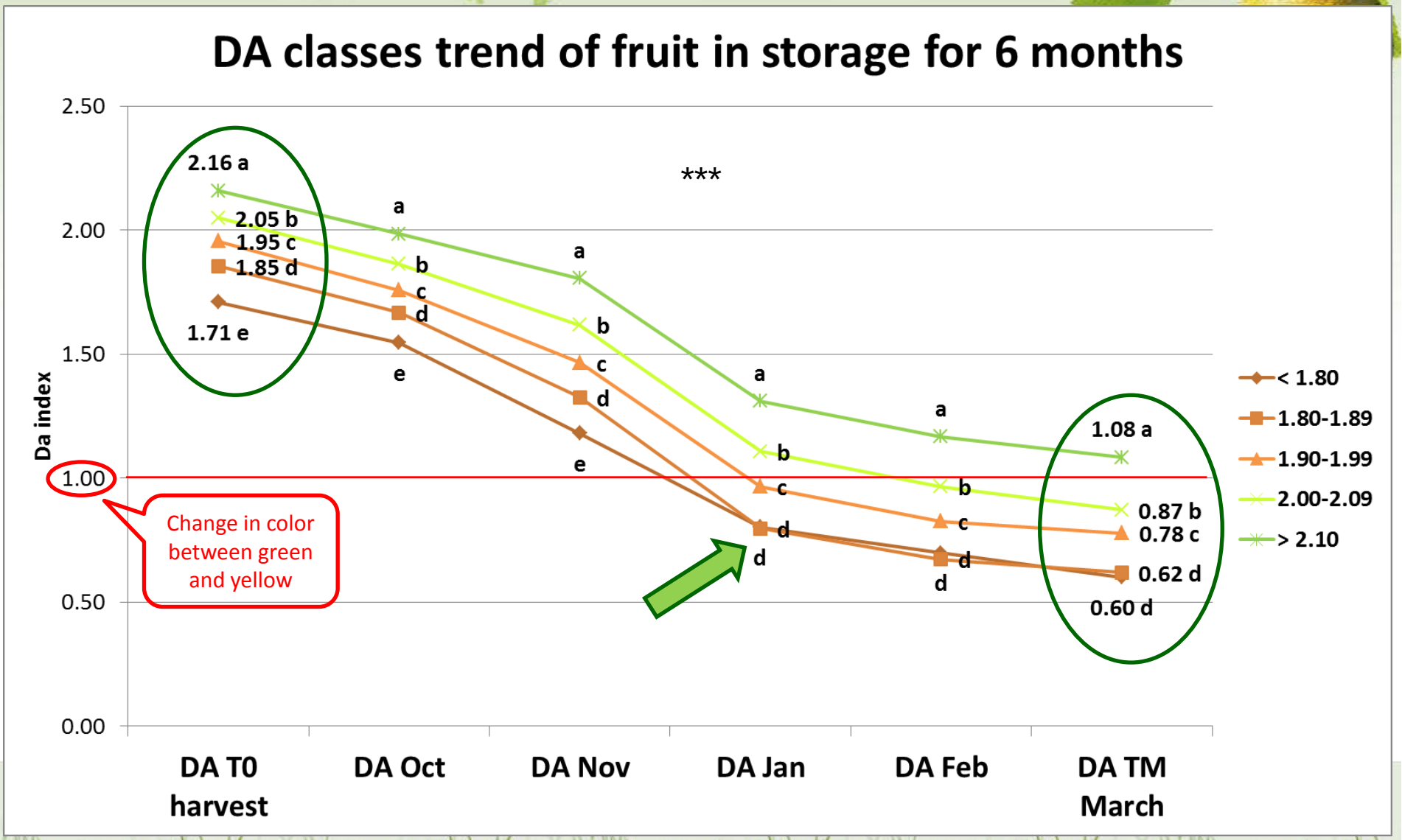
FORM.	sample	year	I_{DA} at harvest	Fruit weight (g)	Russeting %	RATIO H/W	Firmness Kg/cm²	BRIX	pH	acid	L	a	b
twig	At harvest	2011	1,71	361,9	56,0	1,05	4,34	14,60	4,04	2,04	63,41	-11,62	40,9
Spur on axis	At harvest	2011	1,76	351,1	44,0	1,00	4,50	13,33	4,22	1,42	62,28	-9,79	40,8
Old wood	At harvest	2011	1,64	340,4	42,5	0,99	4,32	15,30	3,93	2,11	62,97	-11,86	42,5

Cold Storage

Comparisons between combinations (training/rootstock): DA index trend during 6months of storage



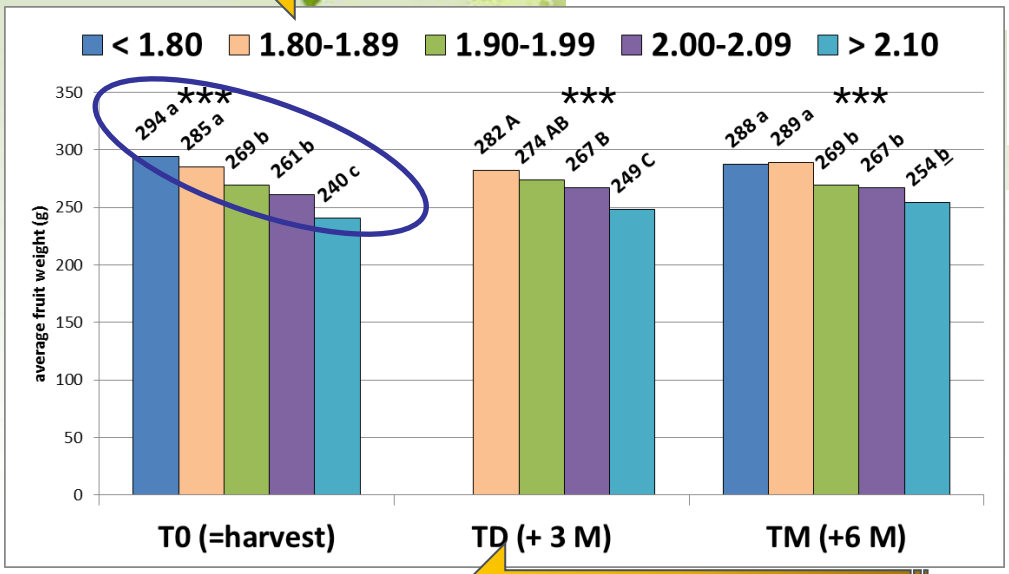
RESULTS


DA classes trend of fruit in storage for 6 months
Da index
2.50
2.00
1.50
1.00
0.50
0.00
***
2.16 a
2.05 b
1.95 c
1.85 d
1.71 e
a
b
c
d
e
a
b
c
d
e
a
b
c
d
d
a
b
c
d
d
1.08 a
0.87 b
0.78 c
0.62 d
0.60 d
Change in color between green and yellow
< 1.80
1.80-1.89
1.90-1.99
2.00-2.09
> 2.10
DA T0 harvest
DA Oct
DA Nov
DA Jan
DA Feb
DA TM March

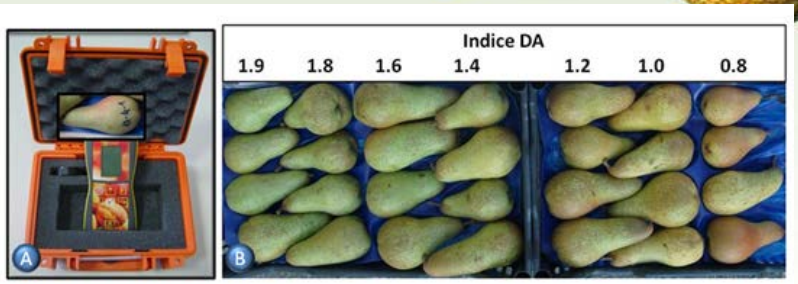
RESULTS

Comparisons between I_{DA} classes and quality parameters

+ maturity -

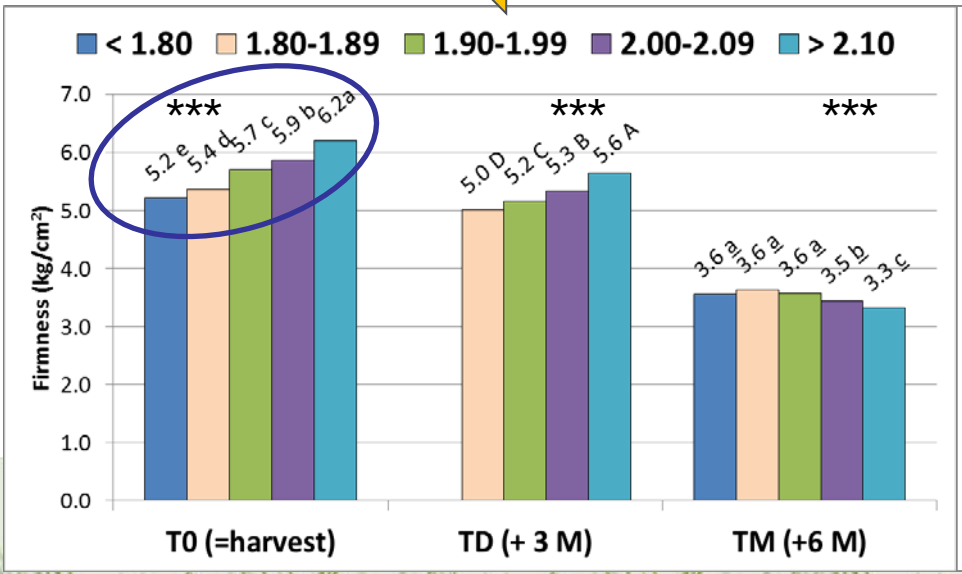


Fruit weight



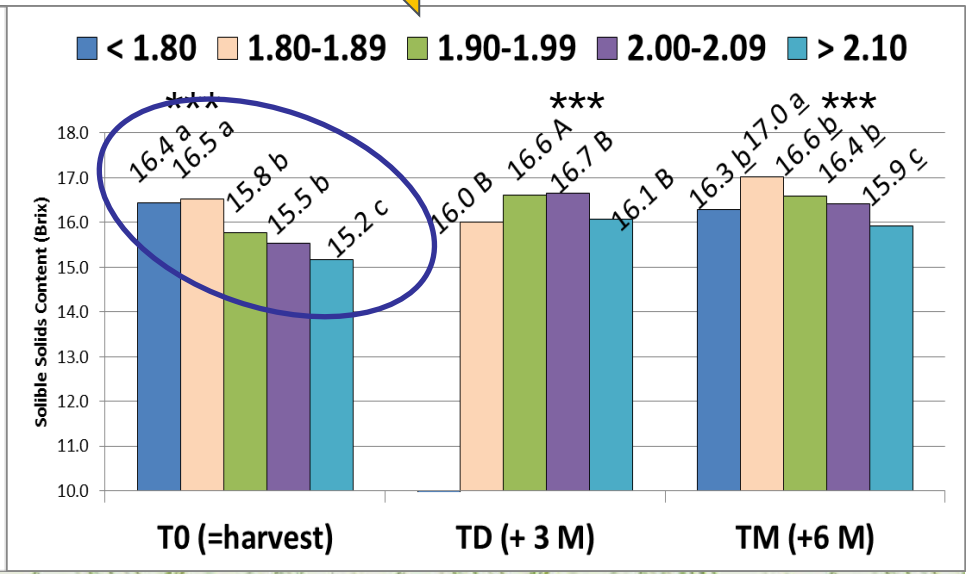
+ maturity -

Firmness (kg/cm²)



+ maturity -

SSC (°Brix)



CONCLUSIONS 1

- DA index can identify difference in ripening among training systems, rootstocks and bearing formations
- V- system fruit exhibits and early ripening compared to the other systems followed by Bi-axis
- Differences among bearing wood distributions has been noted especially in relations with the rootstocks.

CONCLUSIONS 2

- Less ripe fruit with DA index (value > 2) are smaller compare the others.
- It is possible to store the fruits until January without going below the value of 1 considered as reference value for the color change in storage.
- DA index and the firmness are correlated at picking time
- DA index and sugar content are correlated at picking time
- Fruit with high DA index value (> 2.10) never achieved the value of 1 during 6 months of storage.


Thanks for the attention !!

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"Management and crop innovations for high-quality pear production – AGER Innovapero"

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WP1

WP 1
Plant breeding approach for pathogen resistance

WP2

WP 2
Pear quality and productivity optimization

WP3

WP 3
Post harvest

Definition of maturation classes in the field

Thank you for your attention!