University of Novi Sad

Faculty of agriculture

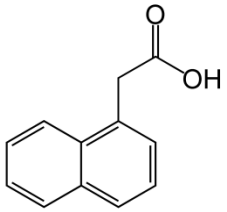
Influence of plant growth regulators on apple fruit ripening

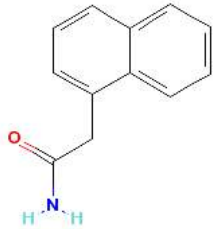
Nenad Magazin, Zoran Keserović,
Biserka Milić, Marko Dorić

INTRODUCTION

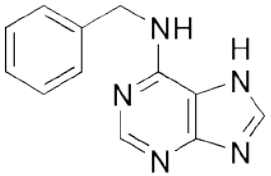
Plant growth regulators in fruit growing

- AUXINS – NAA, NAD

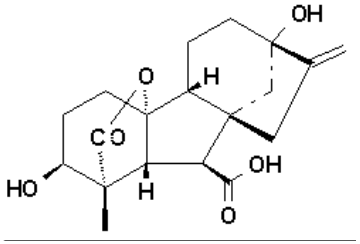




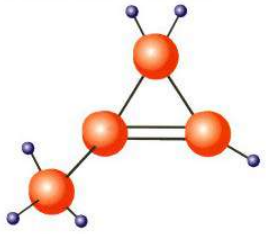
- CYTOKINS - BA



- GIBBERELLINS - GA



- ETHYLENE INHIBITORS– AVG, MCP



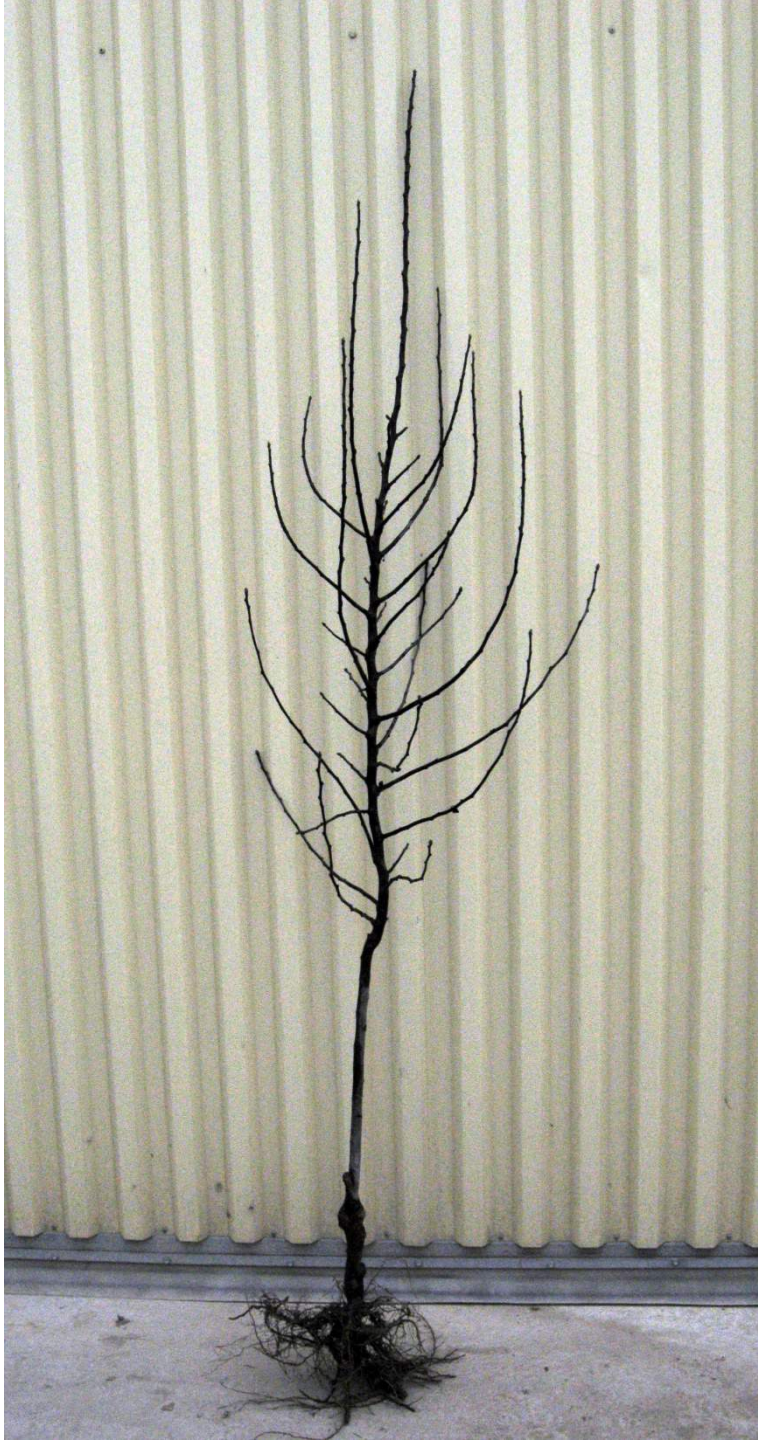
Plant growth regulators in apple growing

- **Plant growth regulators are used in the production of apples at different stages before, during and after growing season:**
- Trees branching (nursery)
- Chemical thinning
- Fruits elongation
- Premature fruit drop prevention
- Fruiting buds development
- Inhibiting ripening processes
- …..

NURSERY PRODUCTION:

Products on the basis of cytokines (benzyladenine) and products on the basis of cytokines + gibberellins are used for branching

Benzyladenine – breaking apical dominance
Gibberellins – cells elongation (growth)



Nursery production

Stimulating branching in orchards

Control

Cytokins applied


Trees fruiting from the first year after planting

Chemical fruit thinning

NAA
(α - naphthaleneacetic acid)

NAD
(naphthalene acetamide)

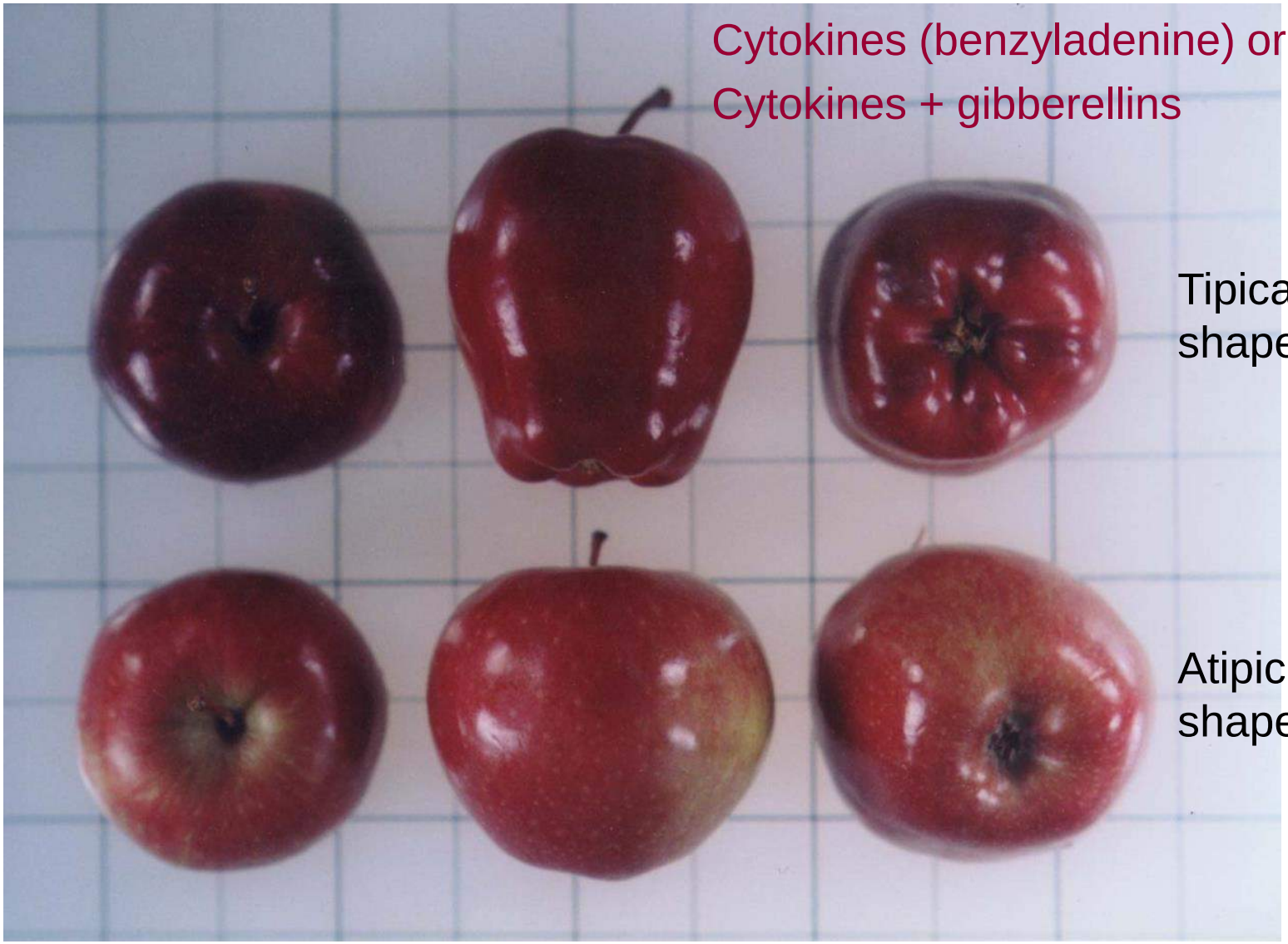
BA (benzyladenine)

5 – 6 mm

6 – 12 mm

10 – 15 mm

Fruits elongation



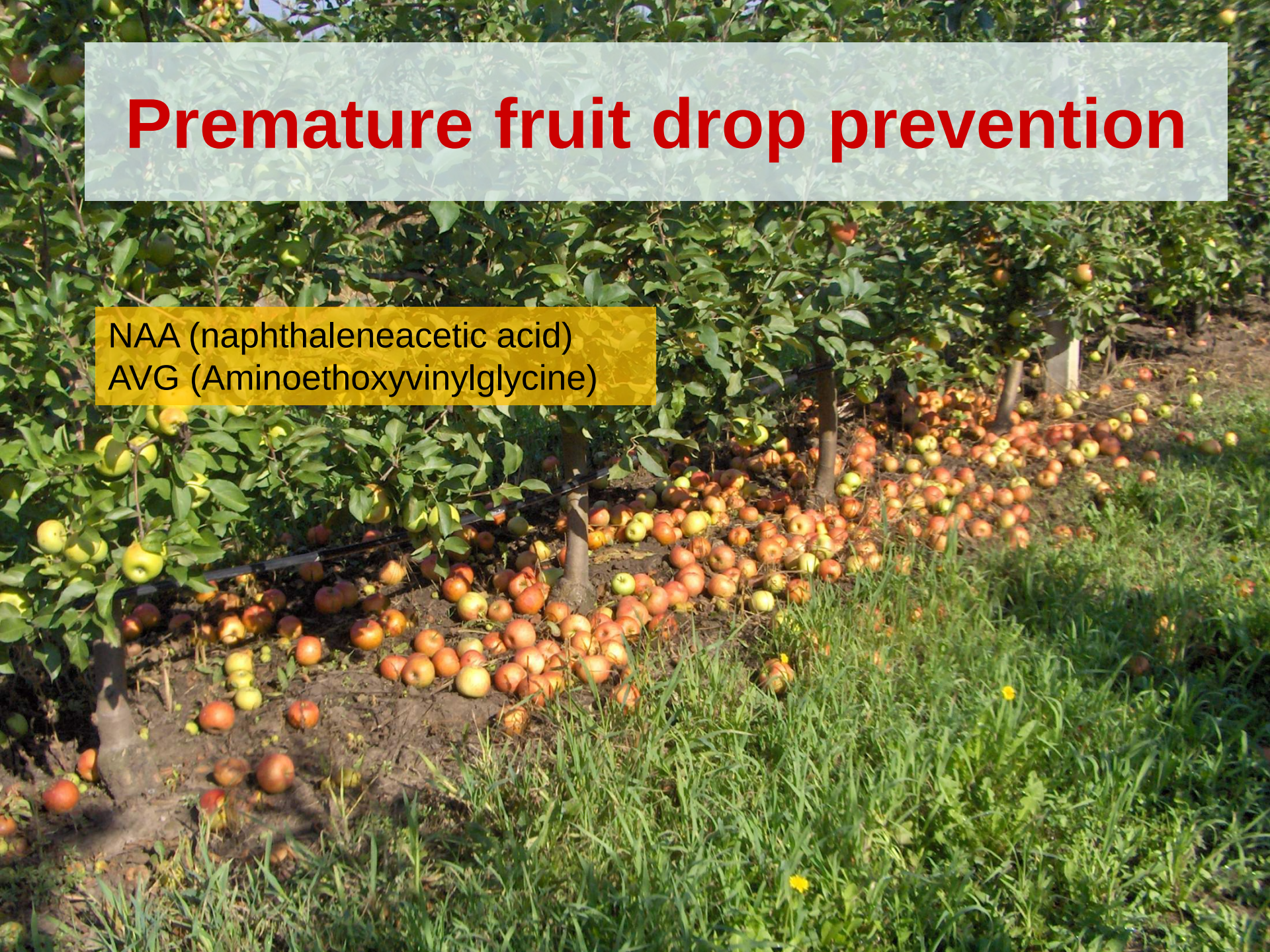
RUSSETING PREVENTION

Mild russeting

Heavy russeting

- Cytokines (benzyladenine)
- Cytokines + gibberellins

Premature fruit drop prevention



NAA (naphthaleneacetic acid)
AVG (Aminoethoxyvinylglycine)

Inhibiting ethylene

1-MCP
1-methylcyclopropene

Objectives

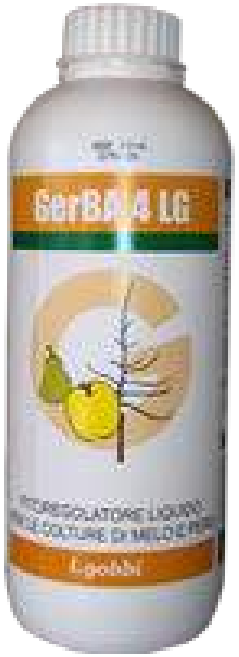
- Some of plant growth regulators have side efects on fruits caracteristics that are associated with ripening.
- This study sumerize different trials over few years where plant growth regulators were used with different objectives (russeting prevention, fruits elongation, premature drop prevention)
- All side effects on fruit ripening were colected

Material and methods

- AUXINS – NAA, NOA
- CYTOKINS - BA
- GIBBERELLINS GA_{4+7}
- ETHYLENE INHIBITORS– AVG, MVP

Products

- Fixormon, (8,5% NAA)
- Dirager, (3,3% NAA)
- Gerba 4LG (4% BA)
- Gerlagib (GA_{4+7} 1,8%)
- Progerbalin LG (BA 1,8% + GA_{4+7} 1,8%)
- VBC 30033 (4.15% AVG) – ReTain



Concentrations

- Fixormon, (8,5% NAA) 20 ppm
- Dirager, (3,3% NAA) 20 ppm

- Gerba 4LG (4% BA) 4-20 ppm

- Gerlagib (GA_{4+7} 1,8%) 4-20 ppm

- Progerbalin LG (BA 1,8% + GA_{4+7} 1,8%) 4-20 ppm

- VBC 30033 (4.15% AVG) – ReTain 125 ppm

Cultivars

- Golden Delicious
- Red Delicious
- Idared
- Gala

Locations

- Mala Remeta
- Sremski Karlovci
- Maradik

Laboratory analysis

- Fruit mass
- Fruit firmness
- Starch iodine test
- Total soluble solids
- Titratable acidity

Results

- BA and GA in russeting prevention + fruits elongation

Golden Delicious, Clone B, 2010, Mala Remeta

Treatment	Fruit mass	Index oblika ploda V/Š	TSS	TA
Control	207,6abc	0,92abcd	**13,33a**	11,33b
GA_{4+7} 3 3x	213,7ab	0,91de	12,93ab	10,13bcd
GA_{4+7} 2,5 4x	195,1bcd	0,93abcd	12,80ab	7,87e
GA_{4+7} 3x	199,7abcd	0,93abc	12,80ab	9,13cde
GA_{4+7} 2,5 2x	208,8abc	0,92cde	12,80ab	10,53bc
GA_{4+7} 2 4x	**218,7a**	0,94ab	13,00ab	9,27bcde
GA_{4+7} 2 2x	203,4abc	0,92cde	13,07ab	8,77cde
BA+GA 1,5 4x	190,1cd	0,94a	13,53a	10,33bc
BA+GA 1,5 3x	206,8abc	0,94abc	12,77ab	8,83cde
BA+GA 1,5 2x	201,5abcd	0,93abc	12,87ab	13,47a
BA+GA 1,25 4x	182,5d	0,92bcde	12,73ab	8,03de
BA+GA 1,25 3x	199,9abcd	0,92abcd	12,63ab	9,70bcde
BA+GA 1,25 2x	208,4abc	0,90e	12,20b	9,67bcde

BA and GA in russeting prevention + fruits elongation
Golden Delicious, Clone B, 2011, Mala Remeta

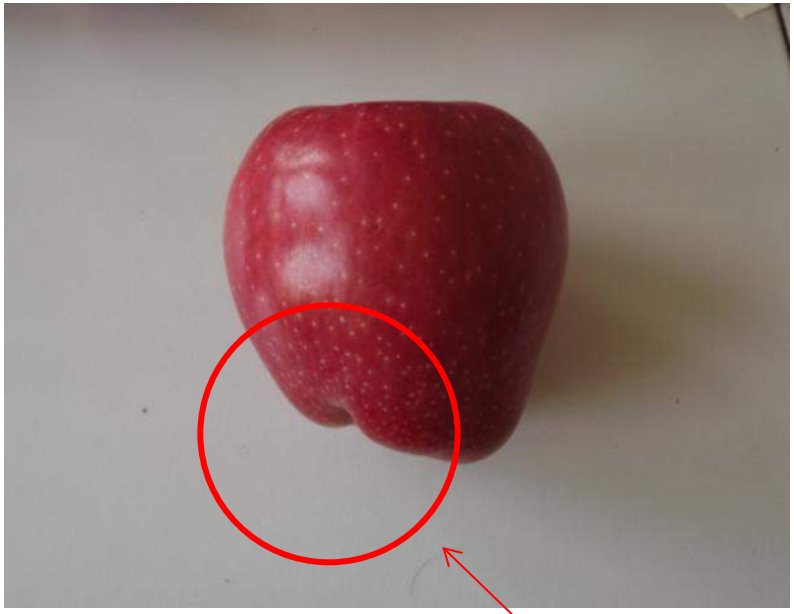
Treatment	Fruit mass (g)	Shape index	Firmness (kg/cm²)	Russeting (%)	
				1	2
GA_{4+7} 2x	194,4c	0,95	8,1cd	70	13
GA_{4+7} 3x	202,8bc	0,96	8,1cd	63	17
GA_{4+7} 4x	195,6c	0,96	8,3bc	57	7
BA+GA_{4+7} 2x	214,8ab	0,95	8,5bc	60	0
BA+GA_{4+7} 3x	200,0c	0,95	8,2bc	57	13
BA+GA_{4+7} 4x	223,7a	0,95	7,8d	53	17
Control	169,4d	0,95	8,7a	40	50

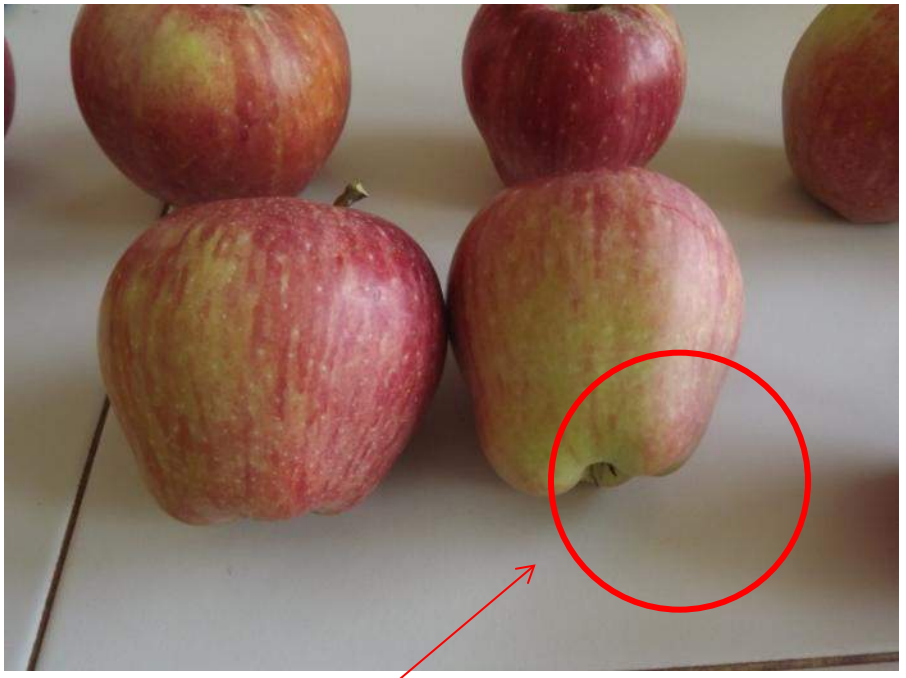
BA and GA in fruits elongation
Red Delicious, Clone Top Red, 2011, Mala Remeta

Treatment	Fruit mass (g)	Shape index	Firmness (kg/cm^2)	Fruits deformity (%)
GA_{4+7} 1x	165,0 bc	0,99 b	9,2 a	10
GA_{4+7} 2x	170,0 b	1,00 b	8,9 b	10
GA_{4+7} 3x	174,1 b	0,99 b	8,8 b	13,3
BA+GA_{4+7} 1x	173,7 b	0,98 b	8,4 c	20
BA+GA_{4+7} 2x	171,6 b	0,99 b	8,7 b	13,3
BA+GA_{4+7} 3x	156,3 c	1,03 a	9,2 a	13,3
Control	196,2 a	0,93 c	8,4 c	0

Control

BA+GA_{4+7}



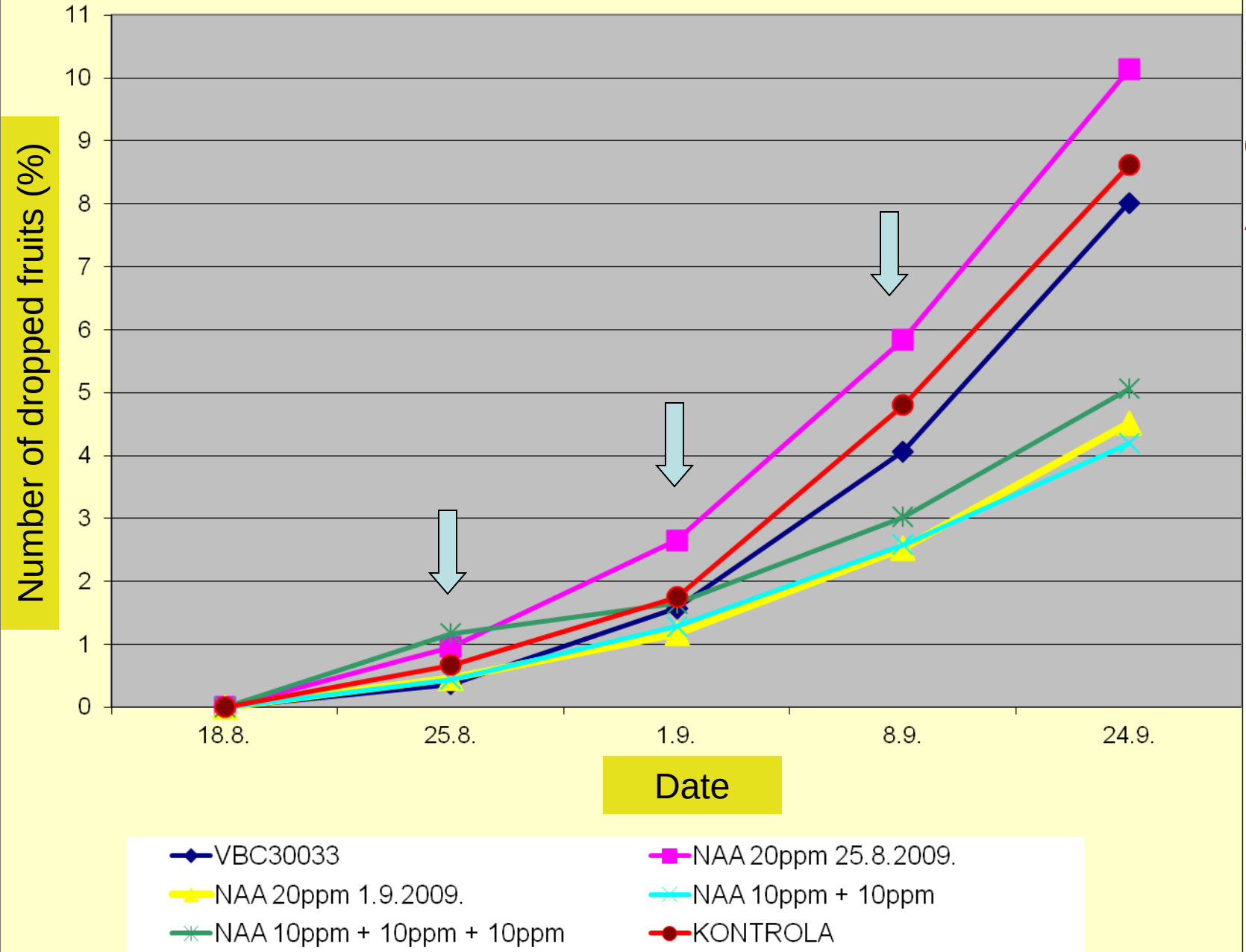


Usage of BA+GA_{4+7} can promote fruits deformities

Results

- NAA and AVG in preharvest drop prevention

Preharvest drop prevention, Idared,Sremski Karlovci, 2008.



NAA 21d

Control

AVG

NAA 3x

NAA 14d

NAA 2x

NAA and AVG in preharvest drop prevention, Sremski Karlovci, 2008.

Treatment	**Mass**	**Firmness (kg/cm^2)**	**Starch index**	**TSS (^{o}Brix)**
AVG - VBC 30033 3.0g/l 11.08.2008.	221,5	6,5	7,9	12,9
NAA - Cifo 0,24ml/l 11.08.2008.	230,4	6,0	8,3	13,7
NAA- Cifo 0,24ml/l 25.08.2008.	230,1	5,7	8,8	13,9
NAA - Dirager 0,6ml/l 25.08.2008.	239,4	5,8	8,1	14,3
Control	216,4	6,3	7,9	12,1

NAA and AVG in preharvest drop prevention, Sremski Karlovci, 2008.

Treatment	**Mass**	**Firmness (kg/cm^2)**	**Starch index**	**TSS (^{o}Brix)**
AVG- VBC 30033 3.0g/l 11.08.2008.	185,7	7,3	7,3	12,8
NAA - Cifo 0,24ml/l 11.08.2008.	192,3	7,0	7,5	12,2
NAA- Cifo 0,24ml/l 25.08.2008.	196,9	7,0	7,4	12,8
NAA - Dirager 0,6ml/l 25.08.2008.	182,9	6.9	8,0	13,4
Control	183,6	6,8	7,3	11,4

AVG, cultivar Gala, Maradik, 2006-2008.

Year	Treatment	Traits		
		Starch index (1-10)	Mass (g)	Colour (%)
2006	Control	8,15b	171,91a	55,22a
	AVG	7,50c	174,42a	51,67b
2007	Control	9,35a	137,72c	45,30c
	AVG	8,59b	148,69a	35,25d
2008	Control	8,23b	133,56c	28,90e
	AVG	7,53c	148,06a	31,77e
Statistical significans:				
	Treatment	**	**	**
	Year	**	**	**
	Year x treatment	NS	**	**


Control


AVG

AVG, cultivar Gala, Maradik, 2006-2008

Days after harvest	Treatment	Firmness (kg/cm^2)		
		2006	2007	2008
Berba	Control	8,30a	8,26b	10,20a
	AVG	8,29a	8,69a	9,58b
30	Control	7,39c	7,91c	–
	AVG	7,82b	8,20b	–
60	Control	7,19c	6,93d	6,41c
	AVG	7,35c	7,62c	6,04d
60 + 7	Control	–	4,77e	5,70ef
	AVG	–	4,96e	5,53f
90	Control	6,27d	6,80d	5,87de
	AVG	6,26d	6,84d	5,92de
90 + 7	Control	5,01e	5,02e	5,15h
	AVG	5,04e	5,09e	5,07h
120	Control	–	–	5,49fg
	AVG	–	–	5,25gh
120 + 7	Control	–	–	4,59i
	AVG	–	–	4,56i
Statistical significans:				
	Treatment	*	**	**
	Analyses date	**	**	**
	Analyses date x treatment	NS	NS	**

Conclusions

	BA	GA	AVG	NAA
FRUITS MASS	↑	↑	↓	↑
FIRMNESS	↓	↓	↑	↓
STARCH DEGRADATION	→	→	↓	↑
TSS (%)	→	→	↑	↑
TA	→	→	↑	→

↑ POSITIVE

↑ NEGATIVE

Conclusions

- Plant growth regulators have a vide usage in apple growing
- Side effects like firmness decrease and starch degradation increase should be taken account when planning applications, but also when checking optimal harvest period.
- Effects are cultivar, site, year affected