Agronomic and Productive Response to Different Concentrations of Gibberellic acid in Green and Purple Heads Artichoke Cultivars.

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INTRODUCTION

- The production of seed propagated artichoke is considered one possible alternative or supplementary way to the propagation by vegetative process.

- The great interest in seed propagated cultivars lies in the reduction in plant failure after planting and to prevent disease expansion through the planting material.

- One drawback of using seed propagated artichoke is their late entry into production.

- It has been well known that plants flower in response to vernalization or photoperiod.

- Seed propagated cultivars must spend all winter or a part of it in order to produce, because of the flowering induction requirements.

INTRODUCTION

- It has been observed that the use of gibberellic acid on those new seed propagated cultivars can induce flowering process, leading to a crop of plants not subjected to low temperatures and achieving great yields during different productive cycles.

- To obtain autumn production with artichokes from seed, it is necessary to use a early cultivar, to plant at the correct time and to spray plants with GA in the exact moment .

- Without GA treatments it is possible to obtain autumn production but not regularly staggered.

INTRODUCTION

- The effectiveness of the treatments depends on several factors, such as, cultivars, sowing or planting dates, rates and number of applications.

- The usual concentrations ranges between 20 and 50 mg L^{-1}

- The splitting of the total amount of GA in different applications have given better results.

- The maximum earliness with applications between September or October in southern areas.

- GA treatment closer to flower initiation would give a lower earliness and the quality of the yield significantly decreased.

OBJECTIVE

- Analyse different concentrations of gibberellic acid (GA) sprayed over different cvs of seed propagated artichoke, in green and purple heads cvs, in order to know the influence over earliness, yield, quality and crop behaviour.

MATERIAL AND METHODS

- The experiment was carried out at the Experimental Station of **Fundación Ruralcaja** in Paiporta (Valencia, SPAIN)

- **Vegetative material**:

  6 seed propagted cvs:

  - 3 green colored (Imperial Star, Symphony and Madrigal)
  - 3 violet colored (Concerto, Opal and Opera)

MATERIAL AND METHODS

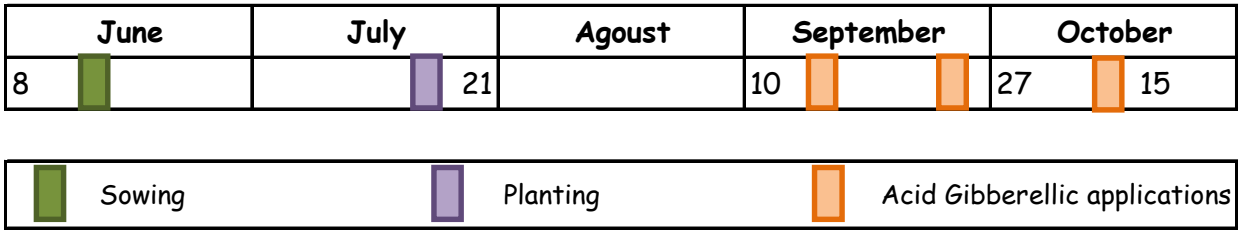
- **Planting frame:** 1.70 x 0.825 m between rows and plants respectively

- **Sowing date**: 8 th June 2010

- **Planting date**: 21 st July 2010

- Plants sprayed 3 times with GA_3 at concentrations 0, 30, 60 and 90 mg L^{-1} (ppm).
  - 10 th September
  - 27 th September
  - 15 th October

- Added a non-ionic wetting agent at 0.1% (v/v) and foliage fertiliser concentrated 1 g L^{-1}



MATERIAL AND METHODS

- Fully randomised design of 2 factors:
  - 6 cultivars
  - 4 GA_3 concentrations

- Each combination 3 replications of 6 plants

- Evaluated early (until end of January) and final production (end May), head artichoke quality and growing plant development.

- During December and January there were several frost which affected almost all the heads artichoke developed.

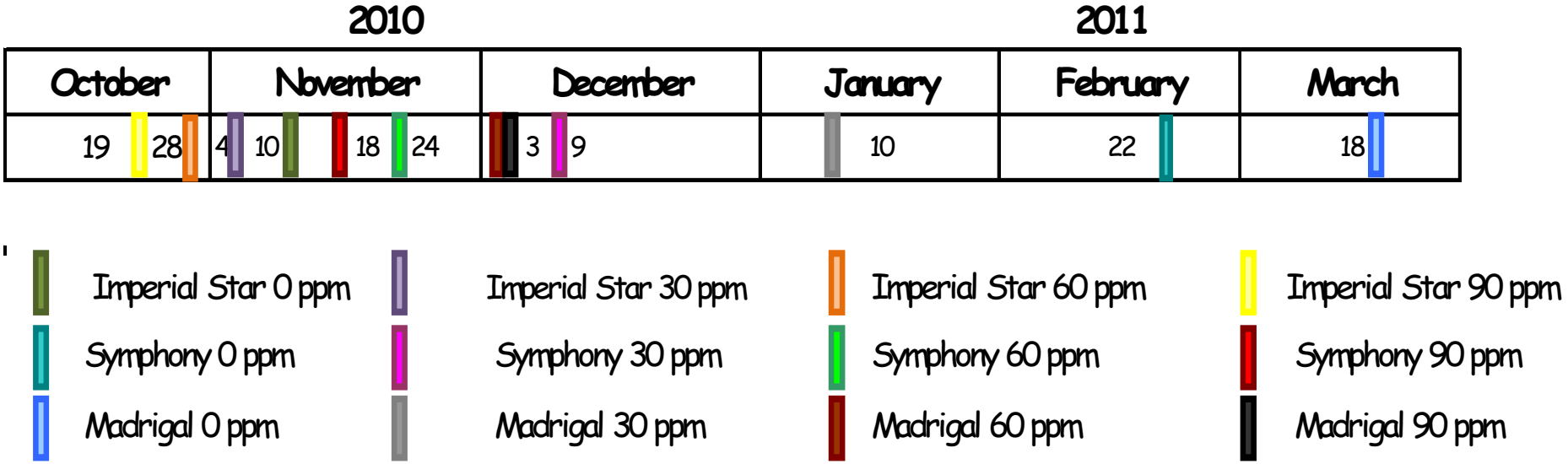
- This accident affected considerably all the production during winter period.

Date	Temp. (ºC)
04/12/2010	-2,5
16/12/2010	-3
17/12/2010	-1
26/12/2010	-3
27/12/2010	-2
28/12/2010	-1
22/01/2011	-4
23/01/2011	-1,5
24/01/2011	-2
25/01/2011	-1

RESULTS OF GREEN COLOURED ARTICHOKE

RESULTS

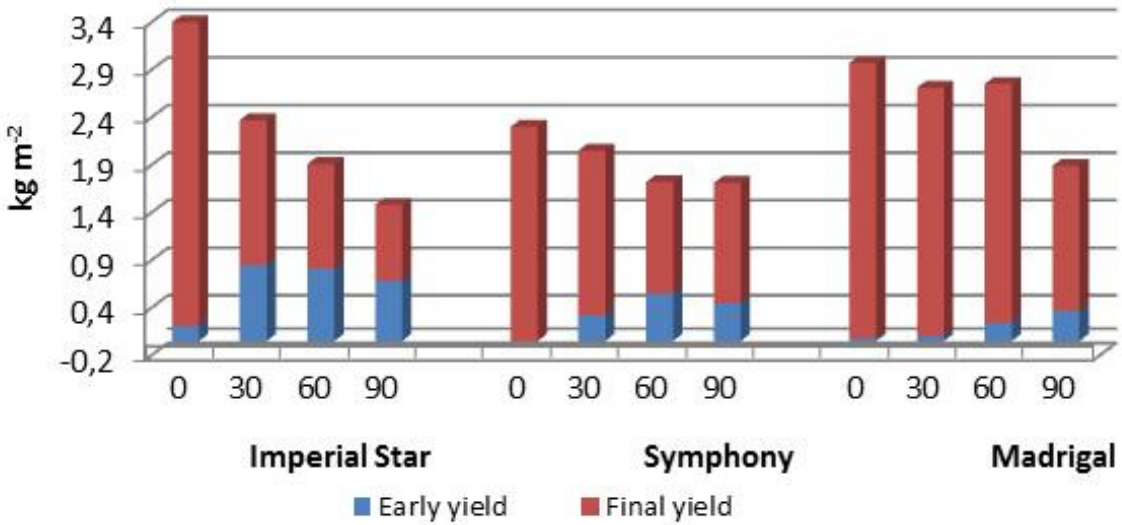
Start of harvest



- Earliest cultivar: "Imperial Star"sprayed with GA concentration of 60 and 90 ppm

RESULTS

Early and Final Total Yield

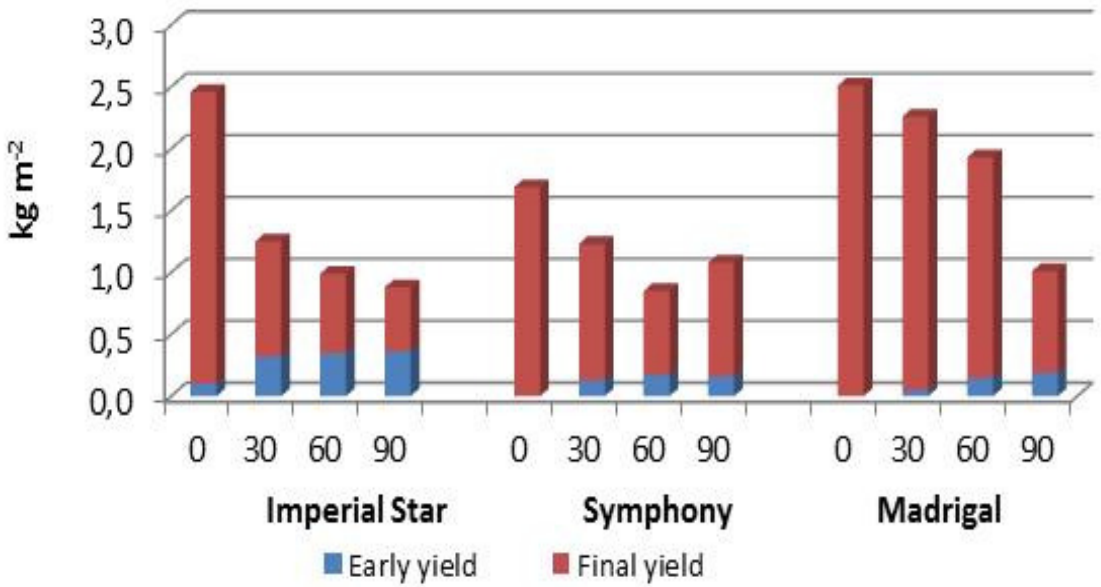


Cultivar x GA concentration (mg L^{-1})	Total yield (kg m^{-2}) Early	Final
Imperial Star		
0	0,16	3,35
30	0,80	2,32
60	0,76	1,86
90	0,63	1,43
Madrigal		
0	0,03	2,92
30	0,05	2,66
60	0,19	2,70
90	0,32	1,84
Symphony		
0	0,00	2,25
30	0,27	2,00
60	0,50	1,67
90	0,40	1,66
LSD (p<0,05)	0,17	0,41
Parameter (degrees of freedom)	Significance level (F)	
Cultivar (2)	**	**
GA concentration (3)	**	**
Cultivar x GA concentration (6)	**	**

- "Madrigal" and "Imperial Star" were the most productive cvs.
- Greatest total yield on "Imperial Star" was achieved by the control, coming down when GA concentrations were higher. In cv "Madrigal" the total yield was reduced with 90 ppm concentration.
- The earliest cv was "Imperial Star"
- GA response is dependent on cultivars, for Imperial Star GA_3 a concentration of 30 ppm was enough to improve earliness, for Symphony 60 ppm and for Madrigal 90 ppm.

RESULTS

Early and Final Marketable yield



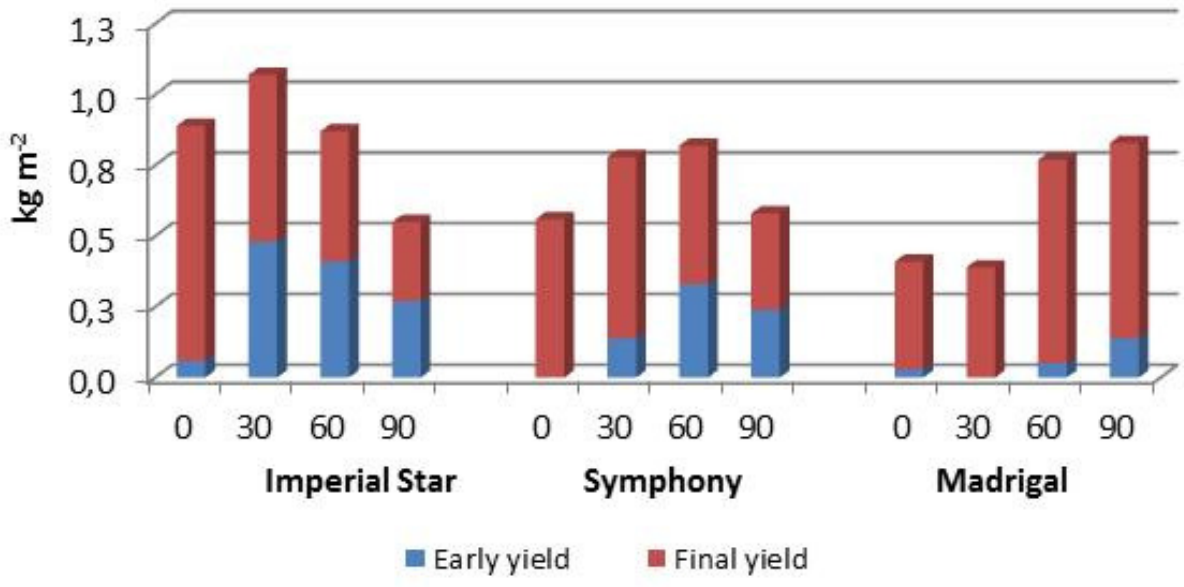
Cultivar x GA concentration (mg L^{-1})	Marketable yield (kg m^{-2}) Early	Final
Imperial Star		
0	0,10	2,46
30	0,32	1,25
60	0,35	0,99
90	0,36	0,88
Madrigal		
0	0,00 b	2,51
30	0,05 b	2,26
60	0,15 a	1,93
90	0,19 a	1,01
Symphony		
0	0,00 b	1,69
30	0,13 a	1,23
60	0,17 a	0,85
90	0,16 a	1,08
LSD (p<0,05)		0,43

Parameter (degrees of freedom)	Significance level (F)	
Cultivar (2)	**	**
GA concentration (3)	**	**
Cultivar x GA concentration (6)	ns	**

- Highest early marketable yield was achieved by cv. "Imperial Star".
- Highest final marketable yield was obtained with cvs. "Imperial Star" and "Madrigal" without GA applications.
- To reach the maximum earliness in "Imperial Star" was enough a concentration of 30ppm
- GA applications reduced considerably the final marketable yield in cv "Imperial Star", being more remarkable for high concentrations. This response was noticed for "Madrigal" with 90 ppm and for "Symphony" with 60 ppm
- Next greatest productive cv was "Symphony" where the maximum earliness was reached with concentration of 60 ppm.
- "Madrigal" was the latest cv and were necessary concentrations of GA between 90-60 ppm to obtain early yield.

RESULTS

Early and Final Non - Marketable yield



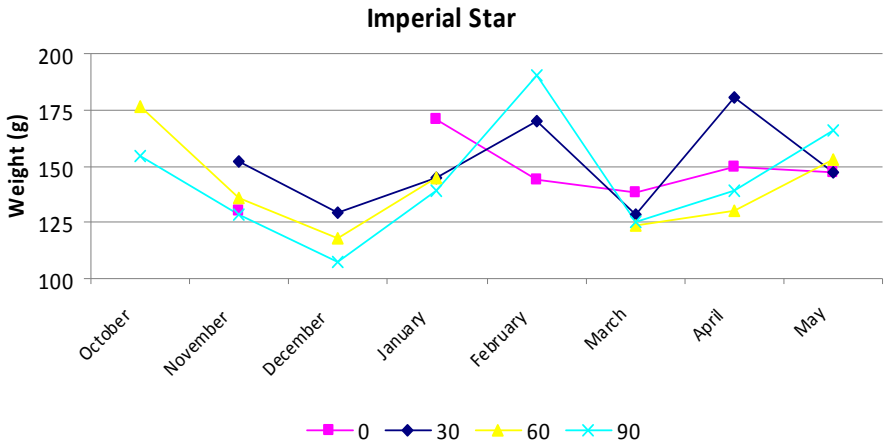
Cultivar x GA concentration (mg L^{-1})	Non-Marketable yield (kg m^{-2})	
	Early	Final
Imperial Star		
0	0,06	0,89
30	0,48	1,07
60	0,41	0,87
90	0,27	0,55
Madrigal		
0	0,03	0,41
30	0,00	0,39
60	0,05	0,77
90	0,14	0,83
Symphony		
0	0,00	0,56
30	0,14	0,78
60	0,33	0,82
90	0,24	0,58
LSD (p<0,05)	0,15	0,43

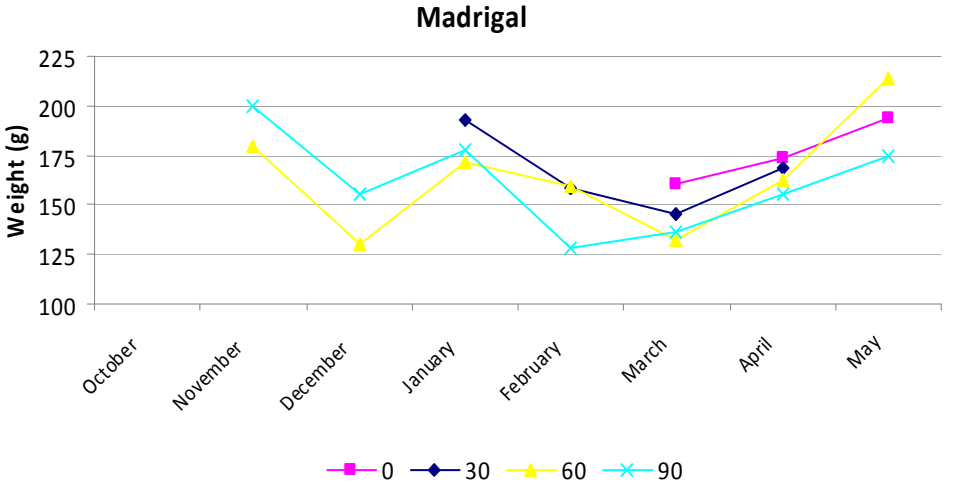
Parameter (degrees of freedom)	Significance level (F)	
Cultivar (2)	**	ns
GA concentration (3)	**	ns
Cultivar x GA concentration (6)	**	ns

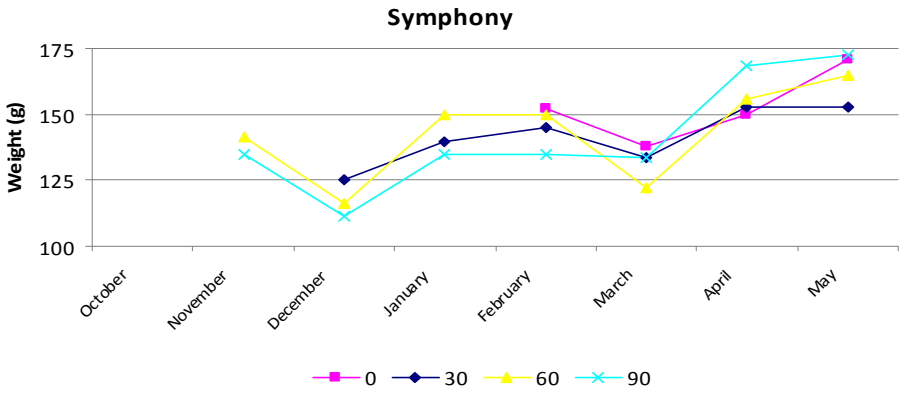
- Largest final non- marketable yield in cv "Imperial Star" with GA concentrations of 30 ppm.
- "Symphony" with GA concentration of 60 ppm had the greatest final non-marketable yield.
- And "Madrigal" at GA concentration of 90 ppm.
- Same results were obtained for early non-marketable yield.

RESULTS

Average marketable weight



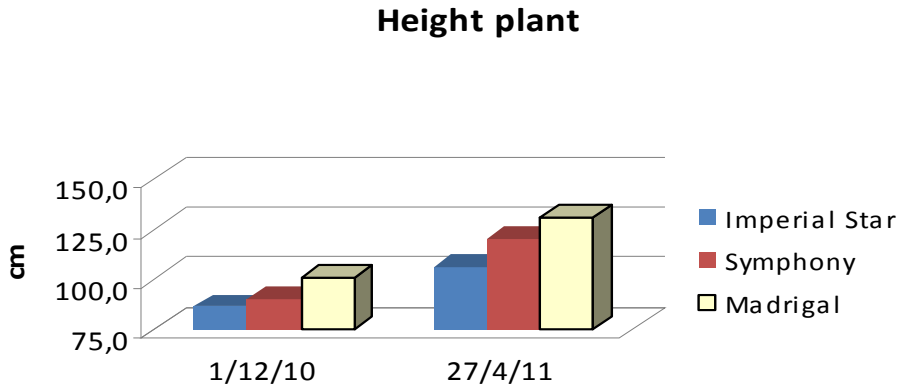




- There were only significant statistically differences in March.
- In control plots were harvested the heads artichoke of biggest weight.

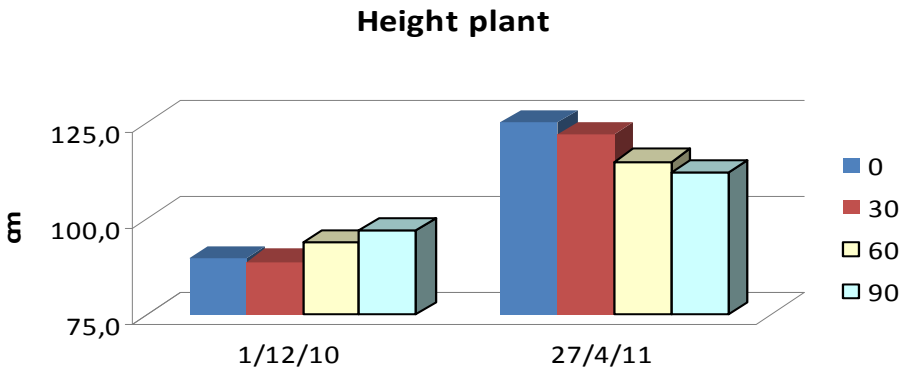
RESULTS

Plant Height



Cultivar x GA concentration	Height plant (cm)	
	01/12/2010	27/04/2011
Imperial Star		
0	90,45	124,45
30	83,67	108,33
60	84,33	96,11
90	86,56	94,22
Madrigal		
0	91,78	134,22
30	94,67	135,11
60	105,34	128,78
90	111,33	125,66
Symphony		
0	86,67	123,00
30	88,22	122,11
60	91,44	119,56
90	92,45	116,11
LSD (p<0,05)	2,17	6,54
Parameter (degrees of freedom)	Significance level (F)	
Cultivar (2)	**	**
GA concentration (3)	**	**
Cultivar x GA concentration (6)	**	**

- In both dates the greatest plant height was reached in cultivars "Madrigal" and "Symphony"



- In the first date the greatest plant height was achieved by 90 ppm AG concentration, followed by 60 ppm.
- In April plants of the control plot reached the best plant height.

Plant Height

0 ppm

30 ppm

60 ppm

90 ppm

Imperial Star

0 ppm

30 ppm

60 ppm

90 ppm

Madrigal

0 ppm

30 ppm

60 ppm

90 ppm

Symphony

RESULTS

Presence of prickles

Cultivar x GA concentration (mg L^{-1})	Level of prickle presence in heads (0-5)		
	01/12/2010	27/03/2011	27/04/2011
Cultivar			
Imperial Star	0,00 b	0,08 c	0,00 c
Madrigal	0,00 b	0,50 b	0,50 b
Symphony	0,33 a	0,96 a	1,17 a
GA concentration (mg L^{-1})			
0	0,11	0,44	0,50
30	0,11	0,44	0,50
60	0,11	0,56	0,61
90	0,11	0,61	0,61

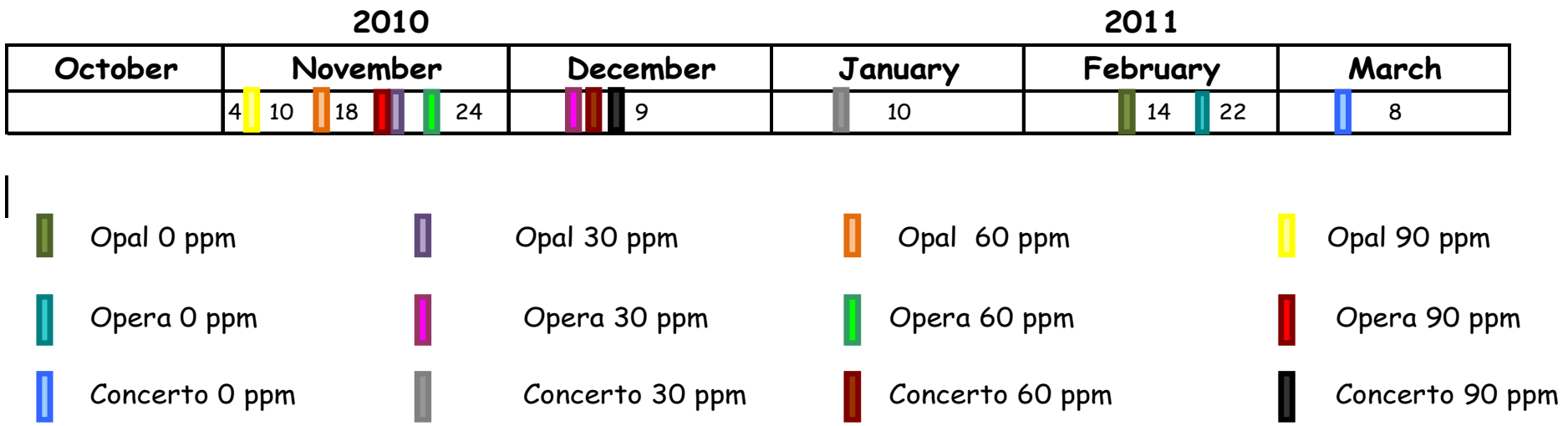
Parameter (degrees of freedom)	Significance level (F)		
Cultivar (2)	**	**	**
GA concentration (3)	ns	ns	ns
Cultivar x GA concentration (6)	ns	ns	*

- They were detected differences between cultivars
- No differences between GA concentrations.

RESULTS OF VIOLET COLOURED ARTICHOKE

RESULTS

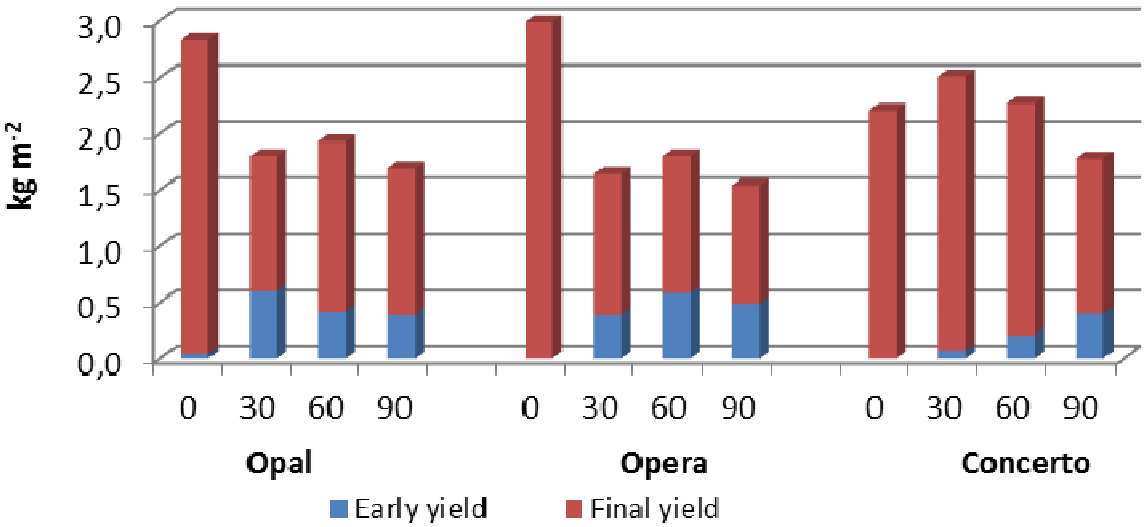
Start of harvest



- Earliest cultivar: “Opal” sprayed with GA concentrations of 60 and 90 ppm.

RESULTS

Early and Final Total yield



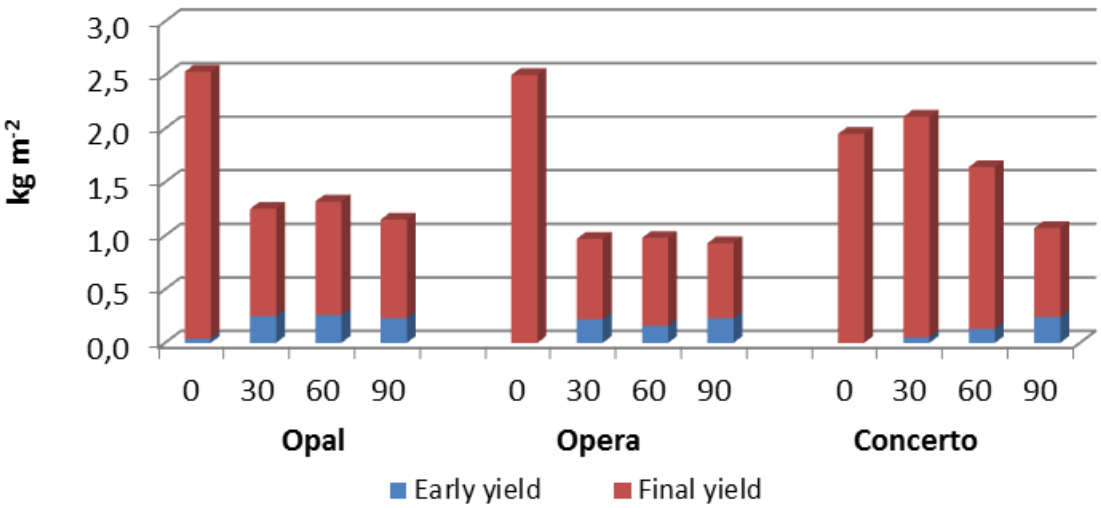
Cultivar x GA concentration (mg L^{-1})	Total yield (kg m^{-2}) Early	Final
Concerto		
0	0,00	2,21
30	0,07	2,51
60	0,21	2,27
90	0,40	1,78
Opal		
0	0,04	2,84
30	0,60	1,80
60	0,42	1,93
90	0,39	1,69
Ópera		
0	0,00	2,99
30	0,39	1,64
60	0,58	1,80
90	0,49	1,54
LSD (p<0,05)	0,18	0,44

Parameter (degrees of freedom)	Significance level (F)	
Cultivar (2)	**	ns
GA concentration (3)	**	**
Cultivar x GA concentration (6)	**	**

- "Opal" and "Opera" reached the largest final total yield with the control.
- Final total yield came down when GA concentrations were stepped up.
- "Concerto" achieved the lowest final yield with the highest GA concentration.
- Largest early marketable yield was achieved by cv. "Opal" with a concentration of 30ppm.
- "Opera", reached the maximum earliness with concentration of 60 ppm.
- "Concerto" was the latest cv and they were necessary GA concentrations of 90 ppm to obtain early yield.

RESULTS

Early and Final Marketable yield

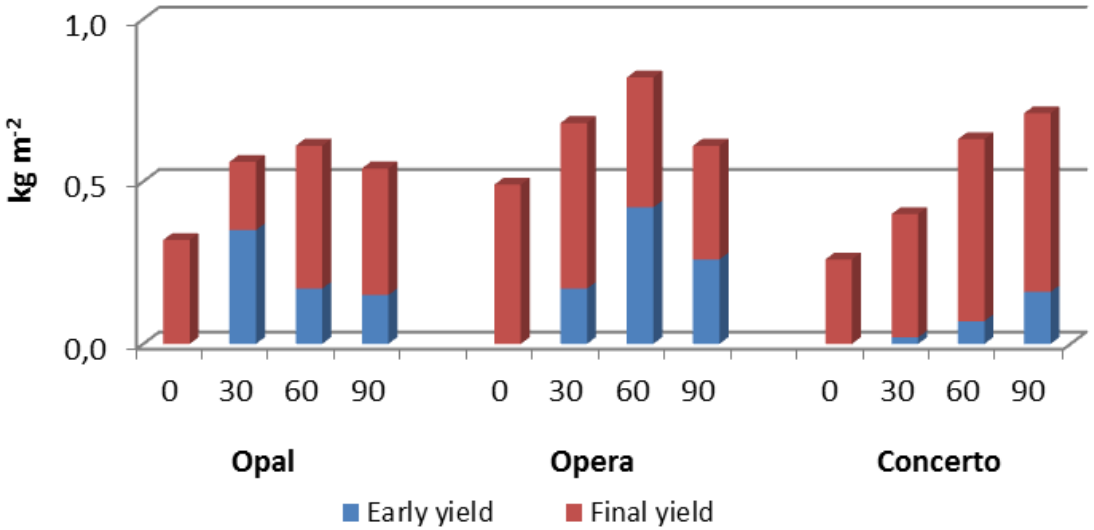


Cultivar x GA concentration (mg L^{-1})	Marketable yield (kg m^{-2})	
	Early	Final
Concerto		
0	0,00	1,95
30	0,05	2,11
60	0,13	1,64
90	0,24	1,07
Opal		
0	0,04	2,53
30	0,25	1,25
60	0,26	1,32
90	0,23	1,15
Ópera		
0	0,00	2,50
30	0,22	0,97
60	0,16	0,98
90	0,23	0,93
LSD (p<0,05)	0,09	0,38
Parameter (degrees of freedom)	Significance level (F)	
Cultivar (2)	**	**
GA concentration (3)	**	**
Cultivar x GA concentration (6)	*	**

- Largest final marketable yield were achieved by "Opal" and "Opera", without GA applications.
- Largest early marketable yield were achieved by "Opal" and Opera".
- To reach the maximum earliness in both cvs was enough with a GA concentration of 30 mg L^{-1}
- GA applications reduced considerably the final marketable yield in cvs "Opal" and "Opera".
- "Concerto" needed GA concentrations of 90 ppm to obtain earliest yield (90 ppm) in cv "Concerto" .
- This response was noticed more remarkable at high GA concentrations

RESULTS

Early and Final Non - Marketable yield



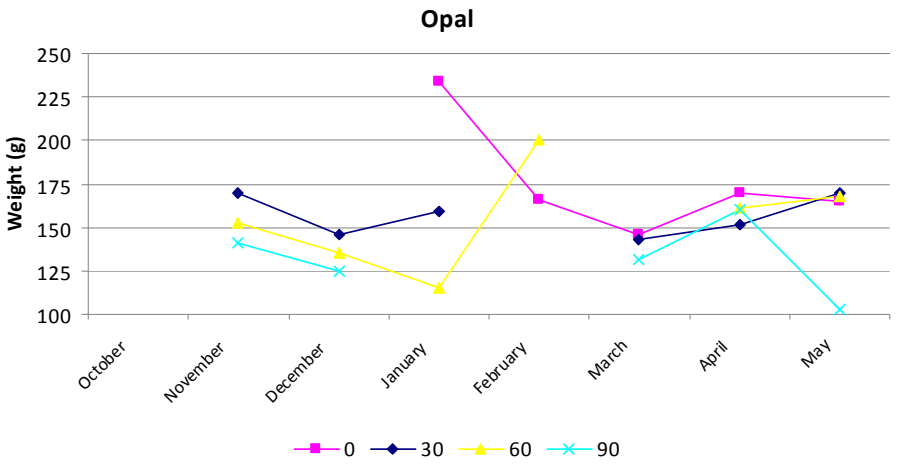
Cultivar x GA concentration (mg L^{-1})	Non-Marketable yield (kg m^{-2}) Early	Final
Concerto		
0	0,00	0,26
30	0,02	0,4
60	0,07	0,63
90	0,16	0,71
Opal		
0	0,00	0,32
30	0,35	0,56
60	0,17	0,61
90	0,15	0,54
Ópera		
0	0,00	0,49
30	0,17	0,68
60	0,42	0,82
90	0,26	0,61
LSD (p<0,05)	0,14	

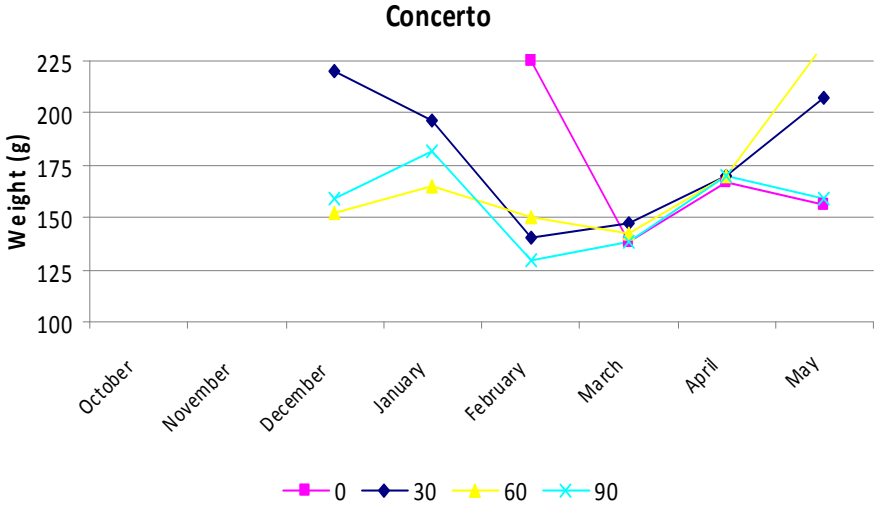
Parameter (degrees of freedom)	Significance level (F)	
Cultivar (2)	**	ns
GA concentration (3)	**	**
Cultivar x GA concentration (6)	**	ns

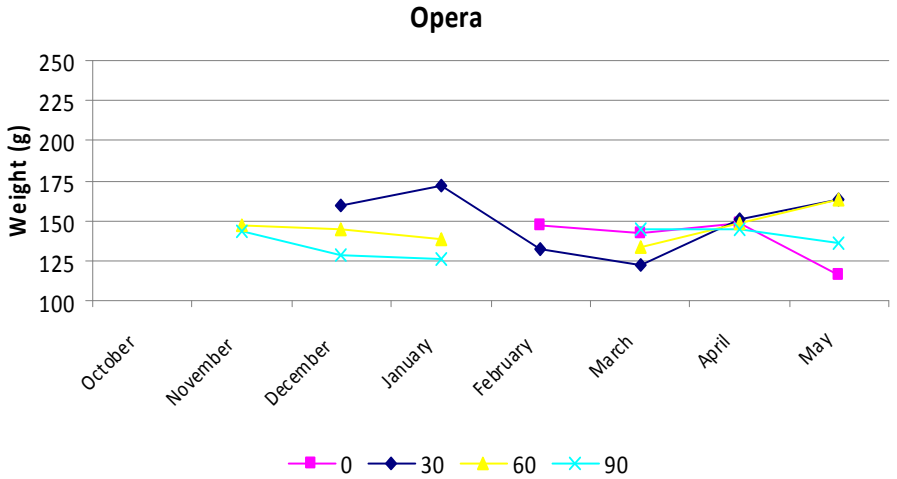
- "Opera" reached the largest final non-marketable yield.
- The lowest final non-marketable yield was achieved by the control (0 ppm) in all cultivars.
- Highest early non- marketable yield reached: in cv " Opal" with concentration of 30 ppm, in cv "Opera" at 60 ppm and in cv "Concerto" at 90 ppm.
- More than a half of non-marketable yield was caused by frost heads.

RESULTS

Average marketable weight



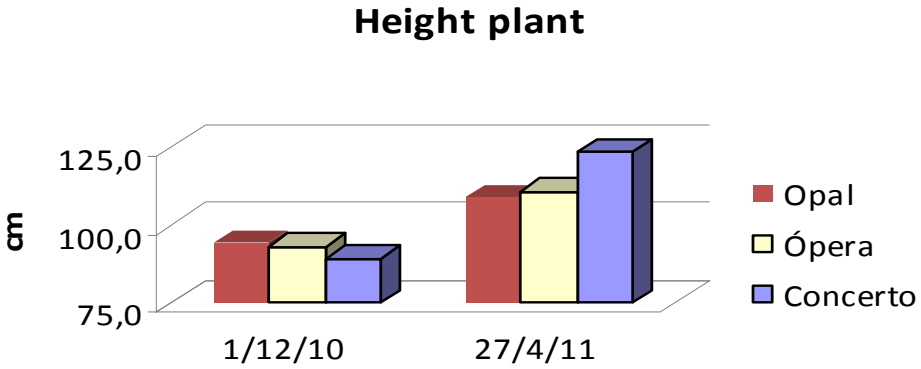




- The highest average weight was achieved by cv " Concerto" sprayed with 30 ppm.
- There were found significant statistically differences in December.

RESULTS

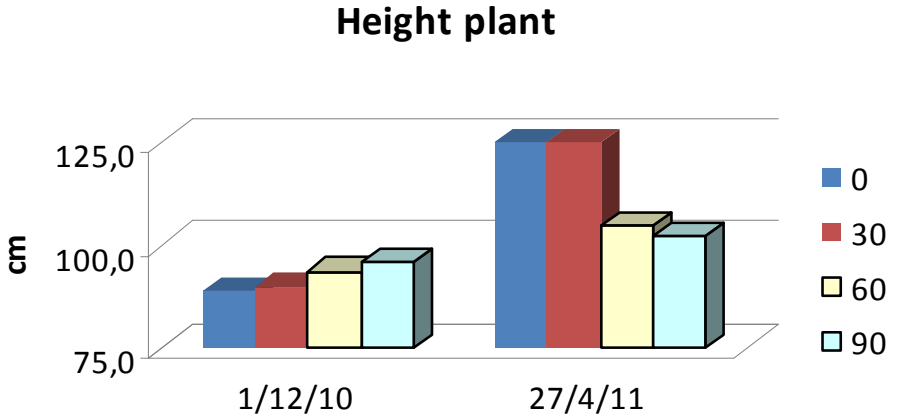
Plant Height



Cultivar x GA concentration	Height plant (cm)	
	01/12/2010	27/04/2011
Cultivar		
Concerto	89,08 b	123,47 a
Opal	93,97 a	109,03 b
Ópera	93,11 a	110,89 b
GA concentration (mg L^{-1})		
0	88,82 b	126,07 a
30	89,78 b	125,07 a
60	93,63 a	104,67 b
90	96,00 a	102,04 b

Parameter (degrees of freedom	Significance level (F)	
Cultivar (2)	*	**
GA concentration (3)	**	**
Cultivar x GA concentration (6)	ns	ns

- In the first date the greatest plant height was achieved by "Opal" and "Opera"
- In April plants of cv "Concerto" reached the best height.



- In the first date the greatest plant height was achieved by 90 ppm AG concentration and 60 ppm.
- In April plants of the control plot and 30 ppm AG reached the best height.

Plant Height

Opal

0 ppm

30 ppm

60 ppm

90 ppm

Concerto

0 ppm

30 ppm

60 ppm

90 ppm

Opera

RESULTS

Presence of prickles

Cultivar x GA concentration (mg L^{-1})	Level of prickle presence in heads (0-5)		
	01/12/2010	27/03/2011	27/04/2011
Cultivar			
Concerto	0,00	0,25	0,50 a
Opal	0,00	0,42	0,54 a
Ópera	0,00	0,25	0,33 b
GA concentration (mg L^{-1})			
0	0,00	0,17	0,44
30	0,00	0,28	0,44
60	0,00	0,39	0,44
90	0,00	0,39	0,50

Parameter (degrees of freedom)	Significance level (F)		
Cultivar (2)	-	ns	*
GA concentration (3)	-	ns	ns
Cultivar x GA concentration (6)	-	ns	ns

- They were detected differences in April between cultivars but not between GA concentrations.

CONCLUSIONS

- Earliest cvs need a lower concentration of GA to produce in autumn (between 30 and 60 ppm)

- For late cvs are necessary highest concentrations of GA (90 ppm) to obtain early yields.

- In general, the greatest final yield was achieved by the control.

- The high concentrations of GA induce a lower final yield, especially in earliest cvs.

- Higher GA concentrations produce initially a greater growing but in last months lowest concentrations and control sprayed plants get a greater height.

- The presence of prickles is not related to GA applications, but there is an incidence according to cvs.