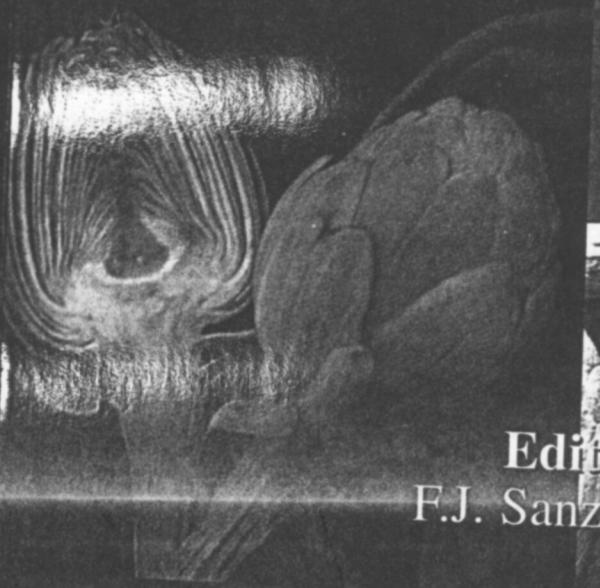
Fifth International Congress on Artichoke

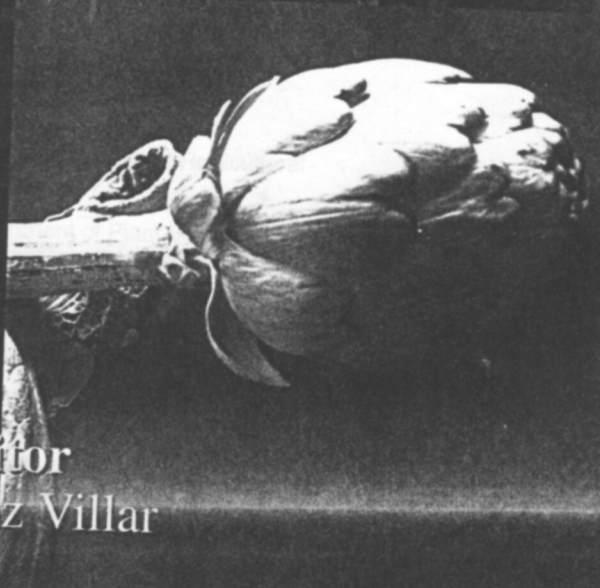
ACTA HORTICULTURAE Number 660

ISHS

Acta Horticulturae
Number 660

Proceedings of the Fifth International Congress on Artichoke





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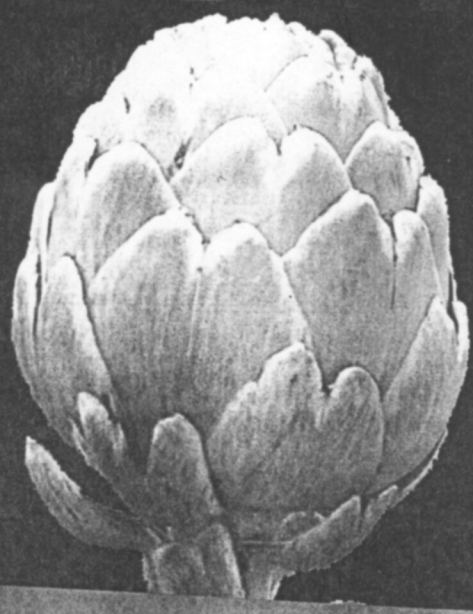

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Influence of Biostimulating Products on Irrigated Artichoke Crop in Southern Italy

G. Sarli[1] and N. Calabrese[2]
[1]CNR, Institute of Plant Genetics Vegetable; via Amendola, 165/a - 70126, Bari, Italy
[2]CNR- Institute of Sciences of Food Production; via Amendola, 122/o - 70126 Bari, Italy

INTRODUCTION

In a context of eco-compatible agriculture, the objective of modern fertilization techniques is to compensate specific shortage or unbalanced plant nutrition. Several experiments have underlined the complex problem of artichoke manuring in early irrigation, in southern Italy (Caruso, 1965). The results obtained have not always furnished reasonable explanations for some biological phenomena and for the probable biochemical processes that the plant puts into effect as an answer to fertilizing elements.

However, the effects of artichoke manuring should not exhaust in to exalt plant productivity and earliness, but should also concern the qualitative improvement of the inflorescences, increase of fruit size, content of sugars, fibres, proteins, amino acids, and so on.

The bio-stimulating involves products are extremely specific. It turned out last years, they interact with plant biochemical processes and therefore are good to improve fruit production and quality. Several firms of the sector have put highly effective products on the market, in many cases represented by plant natural extracts, which also suit well for biological agricultural practice. With the purpose to improve our knowledge on this complex problem and to acquire new information on the action of these products, an active experimentation has been started to test also their effectiveness in combination with the action of plant regulators, whose purpose is to accelerate the mechanisms of differentiation of the vegetative apex and therefore to induce a greater earliness of heads maturation (Marzi, Dellacecca, 1969). The employment of gibberellic acid in artichoke production is almost always justified by the favourable effects of this plant regulator on earliness of heads maturation, as demonstrated by the abundant literature.

This is an essential condition to attain satisfactory economic results, since in southern Italy, the global production of irrigated artichoke fields is not as important as earliness. In fact, when prices are not profitable anymore, artichoke plants are abandoned, even if their heads are still good for heating (Mangano and Signorelli, 1979). Unfortunately, the effects of gibberellic acid on the total head production, head shape, head size and plant habitus are not as clear as for the earliness trait.

MATERIALS AND METHODS

Experiments have been conducted over two years, 1995 - 96 and 1996 - 97, at the Experimental Didactic Center "E. Pantanelli" of the University of Bari, situated near Policoro, in the Metaponto area, a vast irrigated lowland of South Italy, where fruit-culture is prevalent and artichoke crop is strongly present. The experiment has taken place on soil of alluvial origin, slimy-clayey, of good structure and with good physical - chemical characteristics (Prospect 1).

Year 1995-'96

The experiment has been carried out on an artichoke field, installed in the first decade of August 1995, using ovules of the cultivars "Brindisino " and "Violet of Provenza" prepared in hatchery and transplanted with a distance of 1.20 m among the rows and 1.00 m on the row. Before transplantation, a manuring leading with 6 q/ha of mineral superphosphate had been practiced, while, subsequently, manurings in coverage with agricultural urea and ammonium nitrate were added.

When plants reached the development of 8-10 leaves, the first treatment of bio-stimulating was applied, in combination with gibberellic acid at 60 ppm for the whole thesis in comparison; the same products and the same doses were sprayed 20 days later.

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Ed. F.J. Sanz Villar
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The bio-stimulating products sprayed were Biozyme and Sunburst. This last was applied by different doses (Table1). Both are products of large employment on vegetable and fruit crops and are composed by macro and microelements, to which some plant extracts of different nature are associated with the purpose to improve plant bio-stimulating action. The main characteristics and activities of these products are :
- strengthen vegetative and reproductive activity;- favour the flowering and fructification; - increase fruit size; - improve fruit organoleptic and tasting characteristic;- induce a greater plant resistance to biotic and abiotic stresses.

During the cultural cycle, with the purpose to contain *Peronospora* and *Verticillium* attacks, basic treatments of Cymoxanil-Bupirinate were affected, Carbendazim, associating some Azinphos-metil for animal parasites control. For weed control, besides before transplantation treatments with Pendimethalin + Imazamethabenzes, shallow ploughing and a light weeding were necessary. A thinning of offshoots leaving only two plants per spot for harvesting was practiced. After transplantation, irrigators to low intensity "minisplinkler" with a capacity of water disbursement of 6 mm/h were installed. For the whole cultural cycle eight irrigations for a total volume of 2200 m^3 ha^{-1} were used.

The first harvest was made on the 9th of November 1995, picking up heads with about 10 cm long stem and cutting off the leaves; subsequent harvests were continued up to the 10th of April, when it was decided to stop harvesting because of the reduced head size. For every plot the number of heads and their weight after cutting of the stem to 10 cm long and the cutting off of the leaves; only for a sample, the weight of a single head, the caliper (width x height) and the dry material to 60 °C, were recorded. The recorded data were submitted to a statistical analysis of variance and average comparison with the Least Significant Difference (L.S.D.).

Year 1996 – '97

The artichoke field was waked up again on the first of July with an abundant watering (about 1000 m^3 ha^{-1}), while 50 days later a thinning of offshoots was made in order to remain only two plants per spot for harvesting. For the rest, the experimental scheme adopted was as the previous year. The first harvest was carried out earlier than the previous year and this implied an earlier exhaustion of the productive cycle of the plant, which in the following March had no marketable heads.

Meteoric Course

The mean temperatures of the first year were lower than the mean of many years above all in the last ten days of February and in the beginning of March, while in November and December they did not influence negatively the productive trend; in the second year, instead, thermometric values kept normal therefore the productive course was fairly regular.

Rainfall, furthermore, was characterized by a distribution sensibly different on the two years: on the first year turned out mainly rainy October, December and January, while on the second year the whole productive period has been characterized by a frequent and copious rain on January, February and March even if did not registered evident effect on heads production.

RESULTS

In general, the data obtained in two years of experiments show a positive action of the bio-stimulating Sunburst on head production of the two cultivars in comparison. In particular (tab.1) the product applied twice to one l ha^{-1} on the cv. Brindisino induced a significant increase of the principal and secondary heads yield, an increase of the number of the heads/plant and, consequently, of the number of heads ha^{-1}; the average weight of the heads ha^{-1} increased 12% in comparison to the control, passing from 129 to 144 g, though for the secondary heads weight and size increase resulted lower.

The Middle Time of Harvest (MTH) has shown an earlier maturation of the principal heads treated with Sunburst and a more modest influence of the product on the

secondary heads, though in the first experimental year the results show a more regular increase, while in the second year, characterized by a mild autumn and a cold spring, the results show an anticipated emergence of the principal heads and a longer harvesting time for the secondary ones.

To the goals of the exact individualization of the MTH it is however difficult to establish what influence have had the treatments with gibberellic acid or what has been the interaction with the bio-stimulating in anticipating the head emergence. Data have shown, particularly on the principal heads, that treating with Sunburst + gibberellic acid the heads have been picked up 12-14 days earlier than the control.

Similar results were obtained with the cv. "Francesino" or "Violet", for which, equal treatments with Sunburst + gibberellic acid (1 l ha^{-1}), meaningful increases of heads production, both principal and secondary ones, were recorded in comparison to the control; the number of heads ha^{-1} showed also a sensitive and meaningful increase, and accordingly all other traits like the number heads/plant, the weight and the size of the principal and secondary heads, though it seems that, for these latter three traits, because of the high variability among replicates, statistic analysis did not show meaningful results.

The MTH course for 'Francesino' is similar to 'Brindisino', since the more precocious MTH was for the principal head of 113 against 127 days of the control, and for the secondary heads of 160 against the 169 days of the control. Finally it must has been noted that, for the two years of observation, highly positive correlation has been observed for both tested cultivars (R^2= 0, 93 and 0, 83) between heads production and principal head weights, while the secondary head weights resulted less correlated to production, with the only exception of "Brindisino" that, in any case, showed a positive correlation (R^2= 0, 61) (fig. 1, 2, 3 and 4).

Other considerations on the obtained results may be made examining tables 1 and 2.

CONCLUSIONS

Two years of employment of bio-stimulating of organic nature, in association with gibberellic acid on two cultivars of artichoke, largely cultivated in irrigated lands of the South Italy, have provided useful indications on the action of the mentioned substances on yield and other traits of artichoke heads. For both tested cultivars, the dose of 1 l/ha of Sunburst + gibberellic acid applied twice has induced meaningful increases of the production of principal and secondary heads as well as of other traits: number, size and weight of the heads. The same treatments have favoured the anticipation of emergence of the principal heads that have been harvested, on an average of two years, ten days earlier than the control. Treatments with Biozyme have not confirmed the positive results obtained with Sunburst, though in the case of Biozyme the unfavourable results may be due to not optimal doses in synergy with plant regulators. Research in course will contribute to learn more about doses of employment, date of application, possible influence on the phase of transition from the vegetative to reproductive phase of the apex stem and therefore on earliness of maturation. Further investigations on the employment of these products to favour the development of techniques with low environmental impact are needed.

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Tables

Prospect 1

GENERAL DATA RELEVANT TO THE EXPERIMENT

	1995-1996	1996-1997
Previous cultivation	Officinal species	Artichoke (first year)
Preparation field	02/08/95 - Ploughing with pentaploughshare 03/08/95 - Floating and milling	08/07/96 - Milling between the rows after artichoke rousing
Pre-sowing fertilization	03/08/95 - Mineral phosphate 19-21% (8 q ha^{-1}) + Ethoprophos 10 g/m^2 (geodisinfectant)	07/07/96 - Bi-ammonium Phosphate 18-46% (2 q ha^{-1})
Trasplanting date	04/08/95 at a distance of 1,20 m betwen rows and 0,80 m on the row	01/07/96 Artichoke rousing with 100 mm of water
Cultivars tested	" Violetto di Provenza or Francesino" and "Brindisino"	
Weed control	*Pendimethalin + Imazamethabenz* 2 l ha^{-1} (Stomp 330 E + Assert Combi)	16/07/96; *Pendimethalin + Imazamethabenz* 2 l ha^{-1} (Stomp 330 E + Assert Combi)
first biostimolant treatment	28/09/95 - *Sunburst, Biozyme, Giberellic acid*	17/09/96 - *Sunburst, Biozyme, Giberellic acid*
second biostimolant treatment	18/10/95 - *Sunburst, Biozyme, Giberellic acid*	09/10/96 - *Sunburst, Biozyme, Giberellic acid*
third biostimolant treatment	------	22/10/96 - *Sunburst, Biozyme, Giberellic acid*
Fungus treatment	18/08/95 - *Cymoxanil + Mancozeb, Bupirimate, Carbendazim, Azinphos-metyl* (250 g/ha + 100 ml/hl +130 g/hl + 150 g/hl)	15/10/96; 22/11/96: *Azinphos-metyl + Carbendazim* (200 + 250 g/hl) 05/03/97 *Bifenthrin* (1,5 l/ha)
Operation on the plant: **scarducciatura**	01/10/95	25/09/96
Operation during the cultivation	Mechanical weeding between the rows and weeding on the row on 05/02 and 22/03/96 respectively.	Mechanical weeding between the rows and weeding on the row on 07/03/96
Irrigation data	5/8/1995, 8/8; 10/8; 15/8; 22/8; 13/9; 29/9; 15/10; 13/11; 7/2/1996, 18/3; 12/4	05/08/1996; 13/08; 20/08; 28/08; 17/09; 06/11; 20/02/1997; 11/03
Water irrigation volume (m^3 ha^{-1})	2200 m^3	
Cover fertilization	14/10/95 - Urea 2 q ha^{-1} 04/01/96 - Ammonium nitrate 34,4 % 1 q ha^{-1}	13/08/96 - Urea 2 q ha^{-1} 04/11/96 - Ammonium Nitrate 34,4 % 1 q ha^{-1}
Harvesting data	09/11/1995; 16/12; 29/12; 19/01/1996; 06/02; 19/02; 07/03; 18/03; 09/04	09/10/1996; 31/10; 13/11; 19/11; 17/12; 13/01/97; 13/02; 01/03; 14/03; 21/03
Plot area (m^2)	5,0 x 4,0 = 20,0 m^2	
Sampling area (m^2)	5,0 x 2,0 = 10,0 m^2	

Table 1

BRINDISINO

TREATMENTS	Firm Producer	PRODUCTION OF HEADS (t ha⁻¹) Principal 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean	NUMBER OF HEADS PER HECTARE (n ha⁻¹) x 1000 Principals 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean	NUMBER OF HEADS PER PLANT (n°) Principals 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean
[illegible]	-----	2.1	1.3	1.7	6.8	3.0	4.9	16.3	10.0	13.1	60.3	30.0	45.1	1.8	1.9	1.8	6.7	6.3	6.5
[illegible] (500 g/ha) +GA3 (60 ppm/ha) (twice)	Westbridge (California USA)	2.5	1.8	2.2	7.2	5.1	6.1	18.8	13.3	16.0	64.0	48.3	56.2	2.2	2.1	2.2	7.6	8.5	8.0
[illegible] (1000 g/ha) +GA3 (60 ppm/ha) (twice)		2.9	2.1	2.5	8.5	7.9	8.2	19.0	14.3	16.7	77.0	69.7	73.3	2.1	1.7	1.9	8.3	10.5	9.4
[illegible] (2000 g/ha) +GA3 (60 ppm/ha) (twice)		2.3	1.8	2.0	7.5	6.3	6.9	16.0	14.0	15.0	63.5	58.3	60.9	2.1	2.1	2.1	8.5	9.3	8.9
[illegible] (500 g/ha) +GA3 (60 ppm/ha) (twice)	Interbio (Ferrandina,MT-Italy)	2.4	1.9	2.1	7.7	5.5	6.6	17.0	14.3	15.7	64.3	52.0	58.1	2.0	2.0	2.0	7.5	8.4	7.9
MEAN		*2.5*	*1.8*	*2.1*	*7.5*	*5.6*	*6.6*	*17.4*	*13.2*	*15.3*	*65.8*	*51.7*	*58.7*	*2.0*	*1.9*	*2.0*	*7.7*	*8.6*	*8.1*

'F' tables — L.S.D.

YEARS - 0.05= 10.13		1.9		2.9		11.8		24.8		n.s.		n.s.	
YEARS - 0.01= 34.12		n.s.		14.5		n.s.		8.6 **		n.s.		n.s.	
TREATMENTS - 0.05= 5.28				0.6				11.0					
TREATMENTS - 0.01= 5.41				1.4				n.s.					
YEARS*TREATMENTS - 0.05= 3.26		n.s.		n.s.		n.s.				n.s.		n.s.	
YEARS*TREATMENTS - 0.01= 5.41													

BRINDISINO

TREATMENTS	Plants/m² (n°)	HEAD MEAN WEIGHT (g) Principal 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean	HEAD SIZE (Ø x H) (cm) Principal 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean	M T H (days) Principal 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean
[illegible]	0.72	130.8	126.2	128.5	103.8	102.3	103.1	5.9x7.0	6.3x7.4	6.3x7.4	6.0x6.5	6.6x6.8	6.3x6.7	124.4	108.3	116.3	162.6	164.5	163.6
[illegible] (500 g/ha) +GA3 (60 ppm/ha) (twice)	0.78	136.6	131.7	134.1	104.2	105.8	105.0	6.0x7.1	6.4x7.6	6.2x7.4	5.9x6.5	5.9x6.8	5.9x6.7	103.5	111.1	107.3	152.0	167.6	159.8
[illegible] (1000 g/ha) +GA3 (60 ppm/ha) (twice)	0.88	156.5	131.8	144.1	100.8	112.1	106.5	6.0x7.5	6.2x7.4	6.1x7.5	6.0x6.7	6.0x6.8	6.0x6.8	114.7	98.4	106.5	155.9	176.2	166.0
[illegible] (2000 g/ha) +GA3 (60 ppm/ha) (twice)	0.72	140.1	136.1	138.1	107.2	105.9	106.5	6.0x7.3	6.6x7.6	6.3x7.5	5.9x6.8	6.0x6.8	6.0x6.8	110.7	95.1	102.9	149.6	170.2	159.9
[illegible] (500 g/ha) +GA3 (60 ppm/ha) (twice)	0.80	143.7	129.6	136.6	106.1	110.3	108.2	6.0x7.3	6.4x7.5	6.2x7.4	6.0x6.8	6.0x6.6	6.0x6.7	118.7	101.5	110.1	148.7	178.1	163.4
MEAN	*0.78*	*141.5*	*131.1*	*136.3*	*104.4*	*107.3*	*105.9*	6.0x7.3	6.4x7.5	6.2x7.4	6.0x6.7	6.1x6.8	6.0x6.7	*114.4*	*102.9*	*108.6*	*153.8*	*171.3*	*162.5*

'F' tables — L.S.D.

YEARS - 0.05= 10.13	0.30		n.s.		n.s.		2.3		0.8		n.s.		41.8
YEARS - 0.01= 34.12	0.04 **		n.s.		n.s.		n.s.		0.1 **		n.s.		n.s.
TREATMENTS - 0.05= 5.28													
TREATMENTS - 0.01= 5.41	0.07												
YEARS*TREATMENTS - 0.05= 3.26	0.03 *		n.s.		n.s.		n.s.		n.s.		n.s.		n.s.
YEARS*TREATMENTS - 0.01= 5.41													

Table 2

FRANCESINO

TREATMENTS	Firm Producer	PRODUCTION OF HEADS (t ha⁻¹) Principal 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean	NUMBER OF HEADS PER HECTARE (n ha⁻¹) x 1000 Principals 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean	NUMBER OF HEADS PER PLANT (n°) Principals 1995-96	1996-97	mean	Secondary 1995-96	1996-97	mean
[illegible]	-----	2.5	1.3	1.9	7.4	3.5	5.5	17.8	9.3	13.5	57.8	31.3	44.5	1.8	1.6	1.7	5.8	6.2	6.0
[illegible] (500 g/ha) +GA3 (60 ppm/ha) (twice)	Westbridge (California USA)	3.2	1.9	2.5	8.7	8.1	8.4	21.0	13.5	17.3	72.0	72.3	72.1	2.4	1.5	2.0	8.1	8.5	8.3
[illegible] (1000 g/ha) +GA3 (60 ppm/ha) (twice)		3.3	2.4	2.8	8.8	9.2	9.0	20.5	17.5	19.0	68.8	78.3	73.6	2.3	2.0	2.1	7.7	9.6	8.6
[illegible] (2000 g/ha) +GA3 (60 ppm/ha) (twice)		2.9	2.7	2.8	8.3	8.8	8.5	19.8	16.8	18.3	68.5	75.3	71.9	2.1	2.0	2.0	7.2	10.1	8.6
[illegible] (500 g/ha) +GA3 (60 ppm/ha) (twice)	Interbio (Ferrandina,MT-Italy)	2.5	2.5	2.5	7.1	8.9	8.0	17.8	17.0	17.4	55.3	75.3	65.3	2.0	2.1	2.1	6.3	10.2	8.2
MEAN		*2.9*	*2.2*	*2.5*	*8.1*	*7.7*	*7.9*	*19.4*	*14.8*	*17.1*	*64.5*	*66.5*	*65.5*	*2.1*	*1.8*	*2.0*	*7.0*	*8.9*	*8.0*

'F' tables — L.S.D.

YEARS - 0.05= 10.13		n.s.		n.s.		7.3		n.s.		n.s.		n.s.	
YEARS - 0.01= 34.12		0.3 *		1.4 *		n.s.		6.5 *		n.s.		n.s.	
TREATMENTS - 0.05= 5.28													
TREATMENTS - 0.01= 5.41		0.5		1.9		1.0 *		16.0					
YEARS*TREATMENTS - 0.05= 3.26		n.s.		0.9 *		n.s.		n.s.		n.s.		n.s.	
YEARS*TREATMENTS - 0.01= 5.41													

FRANCESINO

TREATMENTS	Plants/m² (n°)	HEAD MEAN WEIGHT (g) Principal 1995-96	1996-97	media	Secondary 1995-96	1996-97	media	HEAD SIZE (Ø x H) (cm) Principal 1995-96	1996-97	media	Secondary 1995-96	1996-97	media	M T H (gg) Principal 1995-96	1996-97	media	Secondary 1995-96	1996-97	media
[illegible]	0.88	149.4	136.3	142.9	113.8	115.8	114.8	6.5x7.5	6.4x7.4	6.4x7.5	6.3x6.9	6.2x7.0	6.3x6.9	140.1	113.2	126.7	157.9	180.1	169.0
[illegible] (500 g/ha) +GA3 (60 ppm/ha) (twice)	0.89	146.3	142.1	144.2	113.7	116.6	115.1	6.7x7.2	6.5x7.5	6.5x7.4	6.6x6.7	6.1x6.9	6.4x6.8	127.3	111.3	119.3	155.6	174.2	164.9
[illegible] (1000 g/ha) +GA3 (60 ppm/ha) (twice)	0.89	156.7	139.7	148.2	117.2	120.9	119.0	6.8x7.4	6.6x7.5	6.7x7.5	6.2x6.8	6.4x7.0	6.3x6.9	112.0	113.0	112.5	157.1	162.1	159.6
[illegible] (2000 g/ha) +GA3 (60 ppm/ha) (twice)	0.93	140.2	153.2	146.7	113.3	121.7	117.5	6.7x7.4	6.7x7.5	6.7x7.5	6.3x7.0	6.3x7.0	6.3x7.0	129.6	106.4	117.5	155.8	165.2	160.5
[illegible] (500 g/ha) +GA3 (60 ppm/ha) (twice)	0.86	140.0	144.5	142.3	119.2	120.8	120.0	6.5x7.2	6.7x7.6	6.6x7.4	6.3x6.8	6.3x7.0	6.4x6.9	146.2	119.8	133.0	154.3	170.8	162.5
MEAN	*0.89*	*146.5*	*143.2*	*144.8*	*115.4*	*119.2*	*117.3*	6.6x7.3	6.6x7.5	6.6x7.5	6.3x6.8	6.3x7.0	6.3x6.9	*130.8*	*112.7*	*121.8*	*156.1*	*170.5*	*163.3*

'F' tables — M.D.S.

YEARS - 0.05= 10.13	n.s.		n.s.		n.s.		0.1		n.s.		91.5		39.2
YEARS - 0.01= 34.12	n.s.		n.s.		n.s.		n.s.		n.s.		n.s.		49 *
TREATMENTS - 0.05= 5.28													
TREATMENTS - 0.01= 5.41	0.04		n.s.		n.s.		n.s.		n.s.		n.s.		n.s.
YEARS*TREATMENTS - 0.05= 3.26													
YEARS*TREATMENTS - 0.01= 5.41													

Figures

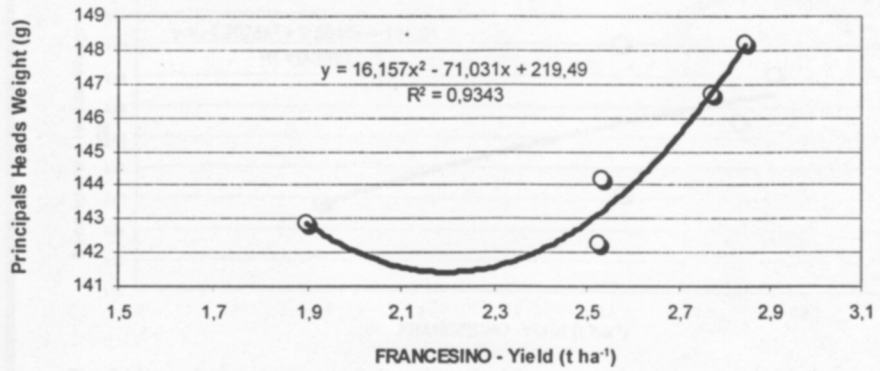

Fig. 1. Correlation between principal heads mean weight and production.

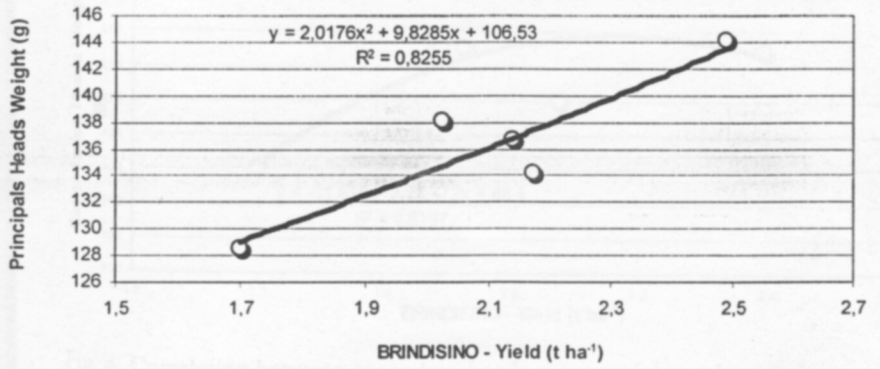

Fig. 2. Correlation between principal heads mean weight and production.

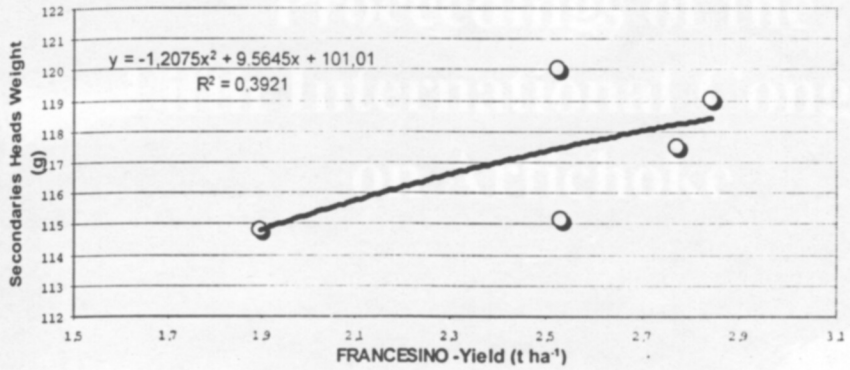

Fig. 3. Correlation between secondary heads mean weight and production.

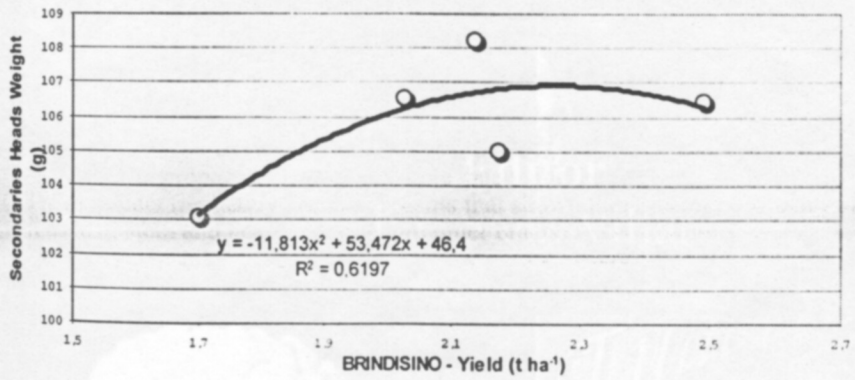

Fig. 4. Correlation between secondary heads mean weight and production.