

## Genetic improvement for crossbreeding in table grape varieties

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**S u m m a r y :** Genetic improvement by crossbreeding of table grape varieties was realized at the Istituto Sperimentale per la Viticoltura for the achievement of the following main targets: early species, seedless species, species with high content of fructose in grapes and, at the same time, a research concerning the hereditary transmission of these features.

The results are the followings:

- Registration in the National Catalogue of the varieties of 4 new table grape varieties that are interesting for their ripening (I.C. 199, I.C. 218, I.C. 120, I.C. 213).
- Information concerning the heritability of earliness, average weight of grape and bunch for the varieties examined.
- Achievement of varieties that have a ratio between the two monosaccharides considerably tending towards fructose. This feature remains constant throughout the years.

**K e y w o r d s :** table grape, variety of vine, Italy, breeding, heritability, berry, bunch, maturation, seedlessness, glucose, fructose.

### Introduction

The cultivation of table grapes in Italy has an economically important position in some regions of Southern Italy such as Apulia and Sicily and a reasonably important position in regions of Central Italy such as Abruzzo and Latium.

The most widely cultivated varieties are: Regina and Italia (I.P. 65) which correspond to 80 % of the total production. The remaining 20 % is produced by earlier ripening cultivars such as Cardinal, Regina dei Vigneti, Panse precoce and Primus.

Therefore, offer of table grapes is concentrated in the months of September and October. While some cultivation techniques employed by viticulturists (e. g. covering) allowed an extension of the aforementioned period, market demand in the month of July can only be fulfilled with early ripening grapes. The simultaneous arrival of large amounts of table grapes in September-October sometimes decreases market prices due to an overabundance.

The current spectrum of table grape varieties would thus require improvements mainly for what concerns the time of ripening; so research institutes have the duty to provide all the information concerning current varieties and new ones to viticulturists in order to meet requirements.

Until recently, practically no seedless table grape varieties were grown in Italy for fresh consumption or raisin production. In fact, Italy is a large importer of raisins. Furthermore, we should point out mind that the markets trends in Italy and abroad are directed towards seedless grapes.

The old seedless cultivars, i. e. Sultanina, Perlette, etc., never met with viticulturists' approval, whereas more recent varieties obtained abroad (Sugraone, Red Flame, Pasiga, Perlona, etc.) are currently being considered.

There is also a plan to obtain cultivars containing large quantities of fructose for direct consumption and for the extraction of monosaccharide, considering its dietetic and physiological importance. This would diversify the market for table grapes.

For all these reasons, the Istituto Sperimentale per la Viticoltura started table grape crossbreedings in 1968 in order to examine the mechanisms of hereditary transmission of the characters that were interesting for this purpose and to produce:

- A) early ripening varieties with good morphological and production characters;
- B) seedless varieties suitable for Italy with a good productivity and early ripening time;
- C) table grape varieties with an elevated content of fructose in grapes.

### Materials and methods

The crossbreeding systems adopted for the various operating programs were as following:

#### A) Earliness

Work began in 1968 using as parents the medium ripening varieties: Italia, Alphonse Lavallée, Baresana, and as early ripening varieties: Perla di Csaba, Volta, Primus, Panse precoce, Regina dei Vigneti, Maddalena Bruni.

Self-pollinations were performed with all varieties. The pattern was subsequently varied by introducing some new varieties produced through previous work, i. e. I.C. 120, I.C. 199, I.C. 218, each of them back-crossed with one of the two parents: Italia (I.P. 65).

#### B) Seedlessness

Work began in 1984 by employing as parents the following varieties with seeds: Italia (I.P. 65), Alphonse Lavallée, Regina, I.C. 199, I.C. 218, and the seedless varieties Perlette, Ruby seedless, Sugraone, and some crossbreedings produced by A. GARGIULO in Argentina, i. e. Perlon, Pasiga, Nerona, etc.

Self-pollinations were performed with all these varieties. Operations were also carried out both with traditional methods and with new *in vitro* techniques (since 1988). *In vitro* culture has been employed to develop both ovules in crossbreedings seedless x seedless and seeds of low germinating varieties such as Regina.

#### C) Glucose/fructose ratio

In 1976 the analysis of the variability of the glucose/fructose (G/F) ratio and of reducing sugar in the different varieties of the ampelographic collection belonging to the Istituto Sperimentale per la Viticoltura allowed us to select some varieties as follows:

- variety A: low ratio G/F (average of 2 years 0.80)
- " B: high ratio G/F ( " " " " 1.21)
- " C: low ratio G/F ( " " " " 0.78)

to be introduced into a program of crossbreeding and self-pollination.

### Results and discussion

#### A) Earliness

Tests carried out on the phenological, morphological and productive characters of the descendants from crossbreedings and self-pollination allowed to acquire important knowledge for the following work.

In particular, the analysis of the transmission of phenological times (budding, blooming, colouring, ripening) to descendants, in order to identify the most suitable parents for breeding early ripening varieties, proved high heritability for the period blooming-colouring and for the total cycle (budding-ripening):  $h^2 = 0.76$  and  $h^2 = 0.69$ , respectively.

The analysis of the phenological behaviour of self-pollinated progeny proved that there is considerable variability among the descendants of crossbreedings and that there may exist two mechanisms of transmission for earliness encountered by us in the types:

- Volta (I.P. 105)
- Perla di Csaba

These results also indicate that the cultivar Volta is a parent capable of transmitting its own earliness to descendants (CALO *et al.* 1980). The analysis also shows that the descendants of the cross Italia x Volta have an elevated heritability for the average bunch weight ( $h^2 = 0.50$ ). These dimensions are intermediate and inclining towards the parent with smaller dimensions. Besides these theoretical results, the study led to the identification of some descendants that were not only interesting because of their early ripening, but also for their organoleptic and morphologic characters.

Four of them were registered in the National Catalogue of Varieties:

- Conegliano 199: Italia (I.P. 65) x Volta (I.P. 105)
- Conegliano 218: Italia x Volta
- Conegliano 213: Italia x Panse precoce
- Conegliano 120: selfing of Italia.

Tables 1 and 2 summarize some characters of these varieties, even compared with their parents.

The cultivation prospects are interesting for the varieties Conegliano 199 and Conegliano 218. In fact, they both have an extremely early ripening (they ripen before Cardinal) and interesting market characters (interesting size grapes and bunch, pleasant and even blue-black colour, particular taste).

Conegliano 120 is similar to Italia from which it originates, although grapes are longer and ripen approximately 2 weeks earlier than the parent. This character makes it interesting because it ripens at a time in which there is not a great flow of grapes to the market.

The two early crossbreedings Conegliano have been tested more thoroughly to verify the effect of some cultural operations which improve the average bunch weight and the size of grapes.

Table 1: Phenological times of new varieties and of parents at Conegliano (averages of years 1986-87-88)

PHENOLOGICAL TIME	VOLTA I. P. 105	PANSE PRECOCE	ITALIA I. P. 65	PERLA CSABA	C. 199	C. 218	C. 213	C. 120
BUDDING	17/4	25/4	20/4	15/4	8/4	10/4	16/4	17/4
BLOOMING	2/6	10/6	6/6	3/6	28/5	1/6	5/6	6/6
COLOURING	18/7	31/7	18/8	15/7	15/7	17/7	8/8	15/8
RIPENING	6/8	8/9	26/9	6/8	6/8	7/8	21/8	10/9

Table 2: Some morphological features of the new Conegliano varieties compared to Italia (I.P. 65)

FEATURE	C 199	C 218	C 213	C 120	ITALIA
AVERAGE WEIGHT OF BUNCH (g)	206	328	316	457	575
AVERAGE WEIGHT OF GRAPE (g)	2,30	3,32	2,70	6,7	7,13

Table 3: Effects of grape bunch thinning on new early varieties (averages of 3 years)

	CONEGLIANO 199		CONEGLIANO 218	
	TEST	THINNED OUT	TEST	THINNED OUT
AVERAGE WEIGHT OF BUNCH (g)	206	263	328	405
AVERAGE WEIGHT OF GRAPE (g)	2,30	3,00	3,32	5,00

Table 4: Effects of some agronomic operations on Conegliano 199 in Apulia

	TEST	THINNING	INCISION	GIBBEREL-	THINN. +	GIBBEREL. +	THINN. +
		OUT		LINS	INCIS.	+INCIS.	INCIS. +
							GIBBEREL
AVERAGE WEIGHT OF GRAPE (g)	2,36	3,60	3,20	3,30	3,92	3,90	5,50
AVERAGE WEIGHT OF BUNCH (g)	205	245	266	277	267	323	374

The tests carried out showed how interesting and favourable the response of the crosses considered were (Table 3). In fact, just grape bunch thinning had favourable effects, especially on Conegliano 218.

Researches carried out in Apulia on the variety Conegliano 199 using different techniques (bunch thinning, giberellic acid, etc.) (Table 4), both simple and combined, confirmed the results.

## B) Seedlessness

Work started, as already mentioned, in 1984, and the plants produced with traditional methods and by *in vitro* techniques are being trained. We obtained the first production in 1989.

Embryo culture provided different results according to the variety.

There is little knowledge concerning the heritability of seedlessness. Some authors believe that it is controlled by some recessive genes (SPIEGEL-ROY *et al.* 1986).

The percentage of seedless individuals in the progenies originated by seeded x seedless crossbreedings seems to be rather low. The use of the seedless x seedless crossbreedings allows an increase in the percentage of seedless individuals, although it may aggravate some negative characters in the existing seedless varieties (small size of grapes, low fertility of buds).

## C) Glucose/fructose ratio

A program of crossbreeding using as parents the varieties (A), (B) and (C) with a different ratio between monosaccharides at ripening was carried out for some years. These tests allowed the production of a group of plants with a G/F ratio more favourable for fructose. The first results have already been presented in a report to the 4th International Symposium on Grapevine Genetics at Verona (CALO *et al.* 1986). In the following years, the observation of the evolution of the ratio in the parents and in the different progenies continued.

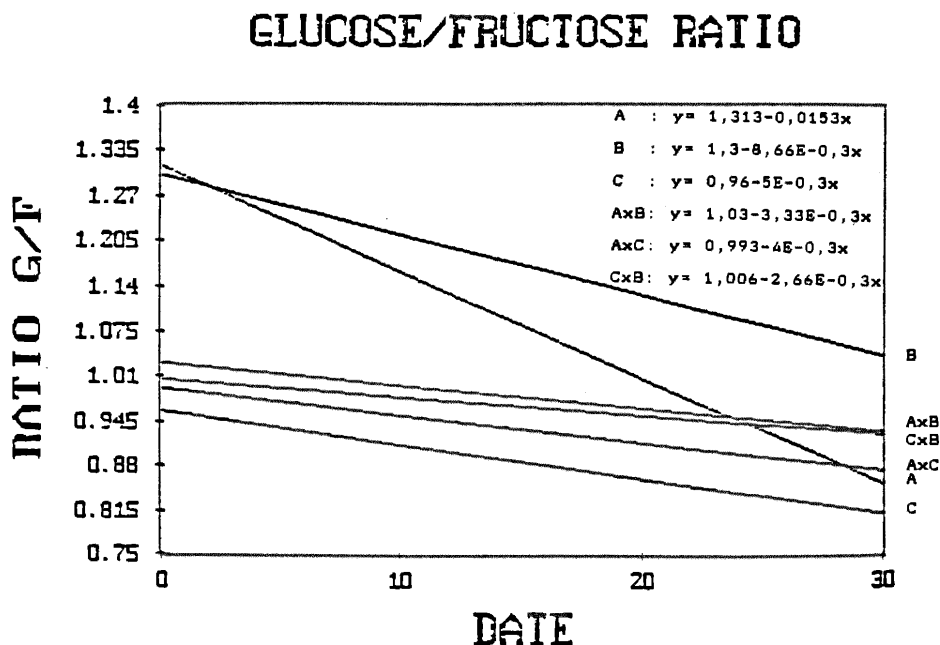


Fig. 1: Course of glucose/fructose ratio in different genotypes during ripening.

The further study emphasized the different behaviour of the two varieties (A) and (C) with a low ratio at ripening, as illustrated in Fig. 1. In fact, type (A) starts with a very high ratio (1.30-1.40) and reaches a low ratio only upon ripening. On the other hand, the low ratio of type (C) starts at the stage of colouring and continues through the entire period.

The analyses of the ratio at ripening confirmed what had already been noticed and illustrated in the previous report. In particular, as can be seen in Fig. 2, there is a movement of the ratio between starting population and population deriving from crossbreeding program, with a manifest increase of fructose as related to glucose.

Fig. 3 shows the marked difference of the G/F ratio in two types of progenies. This difference remains throughout the variability between years, thus confirming the genetic base and polyfactorial origin of the character.

### Conclusions

The results concerning the programs described herein are presently encouraging for the earliness character.

For what concerns seedlessness and the production of varieties with a low glucose/fructose ratio in grapes, considerable variability has been observed among progeny which is important for future studies.

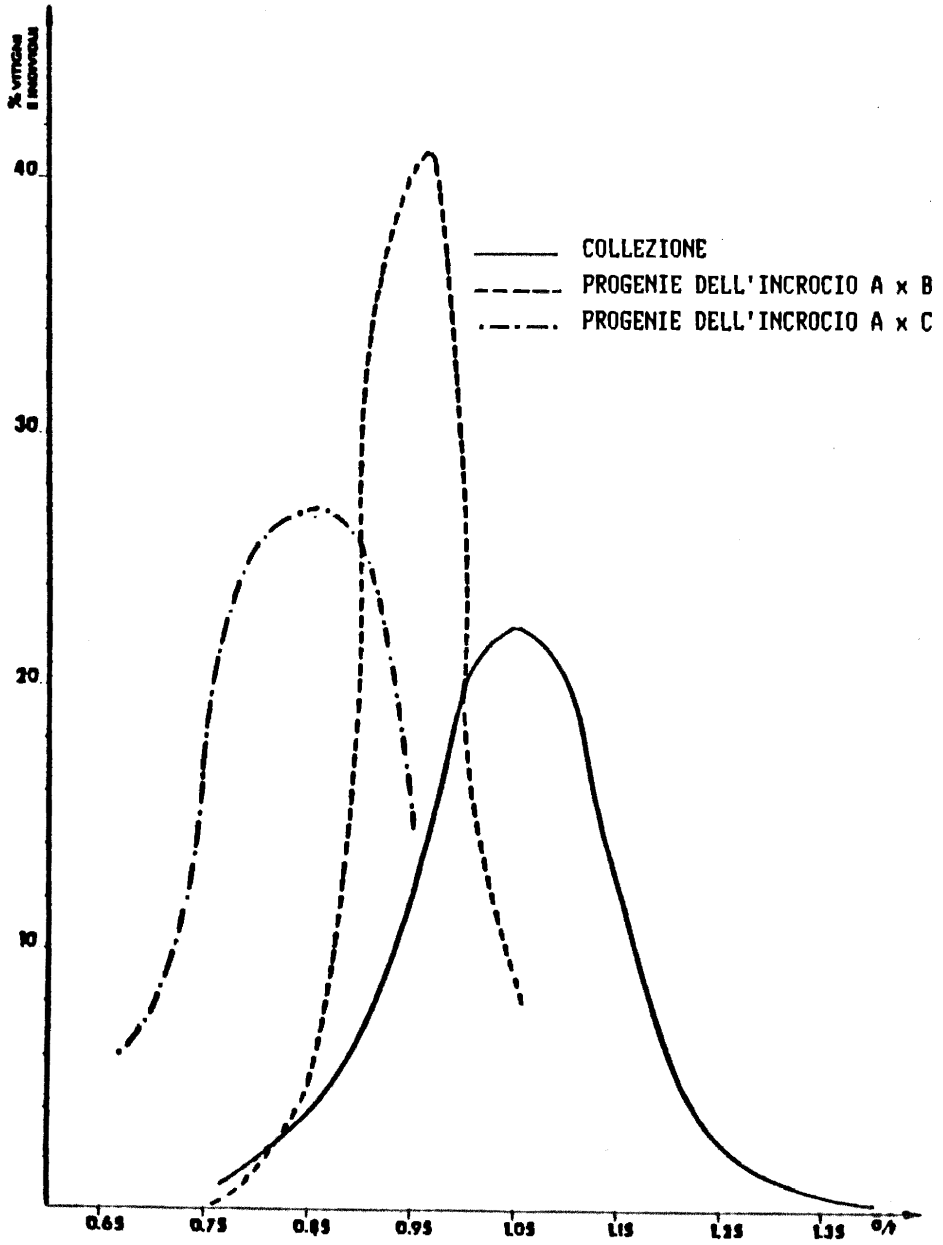


Fig. 2: Distribution of glucose/fructose ratio in the grapevine collection and in crossbreeding progenies.

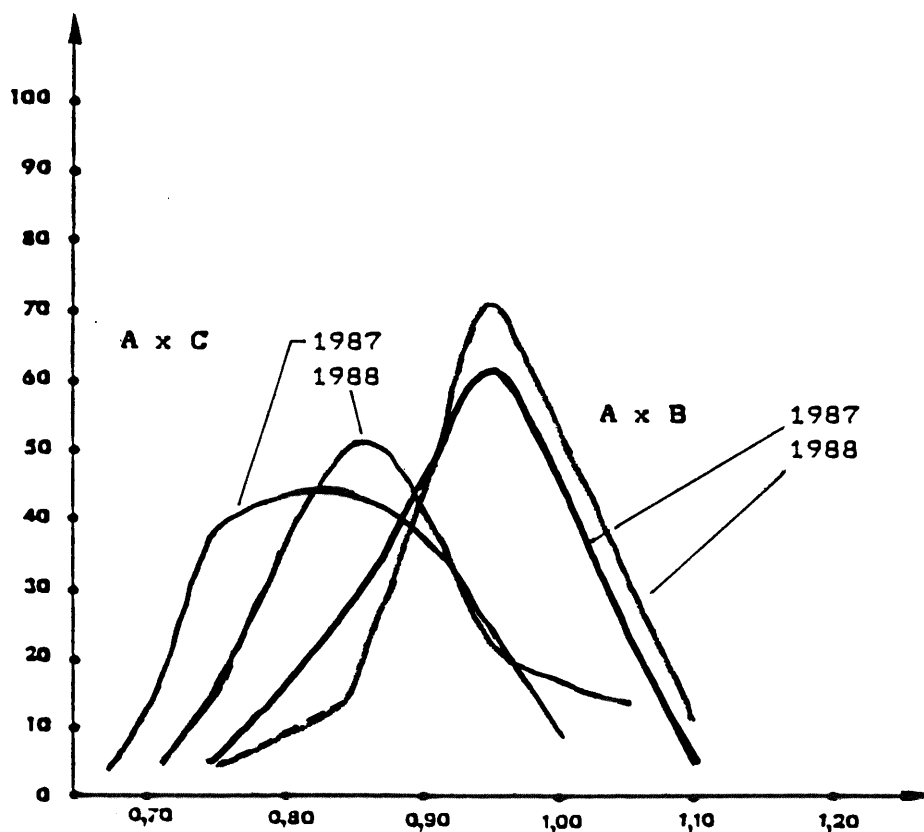


Fig. 3: Distribution of glucose/fructose ratio in two progenies for years 1987 and 1988.

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