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DIPARTIMENTO DI SCIENZE AGRARIE, FORESTALI E ALIMENTARI
UNIVERSIDADE DE LISBOA
INSTITUTO SUPERIOR DE AGRONOMIA

Process and product innovations in the Sicilian vine nursery

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Double Degree – EmaVE Consortium
Corso di Laurea Magistrale Interateneo in
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Academic Year 2013/2014

ACKNOWLEDGEMENTS

Many thanks to:

University of Turin and to I.S.A. of Universidade Técnica de Lisboa for allowing me to study abroad and to live great experiences.

University of Palermo and to S.A.F. department for providing all the infrastructures and all the equipments required for the research.

The supervisor Professor R. Di Lorenzo - University of Turin and Palermo - for the continuous support of my study and research, for its precious advices, remarks, suggestions and guidance.

The doctors A. Pisciotta and - University of Palermo - with deepest gratitude for their precious support that has made possible to carry out this research.

The Vivai Mannone and in particular Alessandro Mannone for all the knowledge that has given me, for the valuable advice dispensed and the availability throughout the experiment.

The Bosman estate (Wellinghton, South Africa) and the Bosman family for the chance to improve my knowledge in the nursery industry and for giving me the opportunity to live a wonderful experience.

ABSTRACT

The nursery business is the starting point for wine production, influence qualitatively and quantitatively all vintages production. The aim of the trial is to deepen the knowledge on certain aspects of the production and some innovative products in the segment of the production of the young vine. Furthermore, will also take into consideration the case of an innovative product in the marketing stage, which takes the name of "barbatellone", which aims to replace the dead vines in the vineyards and anticipate the entry into production of new vineyards.

Results in nursery showed that, the omega grafts affect the nursery success. The yields of field is linked to the time of plantation; later is the period of the plantation and is lower the yield in the field, then you must tend to implant in early periods in order to improve yields.

The evaluation tests related to the techniques to detect the grafts-cuttings suitable to plantation have produced positive results that have shown that it is possible to make other improvements in the production chain.

For the “Barbatellone” the results showed that, the row distances did not affect nursery successful. Instead, plant density influenced the stock and shoot diameters that were increased by the greatest in-row distance.

Results showed that bunch removal. affected shoot elongation, daily shoot growth, stem diameter, pruning mass and root mass. Yield was correlated with the nursery shoot diameter. Prevalence of thin roots (less than 3 mm) was recorded in all thesis.

Keywords: *Nursery - plant material - graft - new plantation - callus.*

RESUMO

A actividade viveirista é o ponto de partida para a produção de vinho, influenciando qualitativa e quantitativamente toda a produção. O objetivo deste estudo é aprofundar o conhecimento sobre certos aspectos da produção e alguns produtos inovadores no sector da produção de plantas de videira. Para além disso, também considera o caso de um produto inovador na fase de comercialização, designado de "barbatellone", que visa substituir as videiras mortas nas vinhas e antecipar a entrada em produção de novos vinhedos.

Resultados em viveiro demonstraram que a enxertia em ómega afeta o sucesso do viveiro. Os rendimentos em campo estão ligados à época de plantação, quanto mais tarde é efectuada a plantação, menor é o rendimento em campo. Assim, deve-se plantar mais cedo de forma a melhorar o rendimento.

Os testes de avaliação relacionados com as técnicas para detectar as plantas adequadas para plantação produziram resultados positivos que têm mostrado que é possível fazer outras melhorias na cadeia de produção. Para o "Barbatellone" os resultados mostraram que a distância na linha não afetou o sucesso no viveiro. No entanto a densidade de plantação influenciou o diâmetro do enxerto pronto que aumentou com o aumento da distância na linha.

Os resultados mostraram que a monda de cachos influenciou o crescimento da parte aérea, o diâmetro do sarmento e o peso da lenha de poda e das raízes. O rendimento foi positivamente correlacionado com o diâmetro das plantas em viveiro. A predominância de raízes finas (menos de 3 mm) foi verificada em todas as modalidades.

RESUMO ALARGADO

Introdução

A actividade viveirista é o ponto de partida para a produção de vinho, influenciando qualitativa e quantitativamente toda a produção. O objetivo deste estudo é aprofundar o conhecimento sobre alguns aspectos do processo de produção e alguns produtos inovadores no segmento de produção de videiras enxertadas, focando a atenção nas técnicas de enxertia e de estratificação utilizadas no viveiro, no período de plantação das plantas enxertadas e estudar um produto muito inovador a ser produzido no viveiro.

Materiais e Métodos

Os estudos foram realizados em anos diferentes no viveiro Mannone Petrosino (TP), tendo sido recolhidos os dados meteorológicos relativos às parcelas experimentais.

A tese foi dividida em duas partes. Na primeira parte compararam-se dois tipos diferentes de estratificação (serradura e água) e de enxertia (ómega e encaixe múltiplo), dois períodos diferentes de plantação no campo (primeira plantação: 11 de Abril; segunda plantação: 15 de Maio) e duas técnicas experimentais para controlar a qualidade das estacas enxertadas antes da plantação no campo. Para estes ensaios, foram calculadas as percentagens de sucesso da enxertia depois da estratificação e após a plantação para as várias combinações utilizadas. As duas técnicas inovadoras para controlar a qualidade das estacas enxertadas consistiram num estudo colorimétrico do calo de enxertia antes da plantação das estacas enxertadas e num estudo termográfico do calo de enxertia através de um termovisor. O primeiro estudo foi realizado por meio de um colorímetro que comparou três parâmetros da cor do calo (claro, intermédio e escuro) em duas combinações (casta/porta-enxerto) de estacas enxertadas. Os parâmetros de qualidade das estacas enxertadas foram correlacionados com a análise realizada pelo colorímetro.

O estudo com termografia foi realizado em três lotes diferentes: os dois primeiros lotes com estacas enxertadas de primeira e segunda escolha e o terceiro lote considerando apenas estacas enxertadas de elevada qualidade. Em todos os lotes foram feitas as medições térmicas, isto é, foram medidas as curvas de aquecimento e arrefecimento para a área do calo através de um gerador de imagens térmico que mede a temperatura.

A segunda parte do trabalho centrou-se no estudo de um produto inovador, o "barbatellone", para a substituição das videiras mortas na vinha, melhoramento da uniformidade da vinha, sincronização das práticas de gestão da vinha durante os dois primeiros anos de plantio e antecipação da primeira colheita. O estudo foi realizado durante dois anos, tendo sido o primeiro ano do ensaio baseado na produção de material para a produção de "barbatellone" e o segundo ano baseado na análise dos parâmetros vegetativos e produtivos do “barbatellone".

Resultados e Discussões

Relativamente aos rendimentos no campo, os diferentes tipos de enxertia revelaram algumas diferenças, enquanto que, os diferentes tipos de estratificação não produziram quaisquer diferenças significativas.

No que se refere ao estudo do efeito da época de plantação nos rendimentos no campo, os resultados revelam que o factor estudado influencia a produção de enxertos-prontos. Na segunda quinzena após a segunda data de plantação, os valores de temperatura e humidade relativa são mais elevados e a velocidade do vento é menor relativamente à segunda quinzena após a primeira data de plantação. Os efeitos de baixa produtividade obtidos no campo foram principalmente atribuíveis a fatores climáticos que ocorrem durante os primeiros 15 dias após a data de plantação, nomeadamente temperatura e velocidade do vento elevadas e humidade relativa baixa.

O estudo com o colorímetro revelou que um dos parâmetros analisados pelo instrumento está em estreita relação com os parâmetros do enxerto-pronto no campo, enquanto que a termografia mostrou que, de facto, há uma relação entre as curvas de aquecimento e arrefecimento do calo e a qualidade das estacas enxertadas.

No estudo que considerou o "barbatellone" obtiveram-se resultados diferentes no viveiro e no campo. Os resultados obtidos no viveiro mostraram que a distância na linha não afetou o sucesso no viveiro, tendo apenas as variedades apresentado efeitos significativos. No entanto, a densidade de plantação influenciou o diâmetro dos enxertos-prontos que aumentou com o aumento da distância na linha.

Os resultados em campo mostraram que a monda de cachos influenciou o crescimento da parte aérea, o diâmetro do sarmento, o peso da lenha de poda e as raízes. A produtividade foi fortemente correlacionada com o diâmetro das plantas em viveiro. A predominância de raízes finas (menos de 3 mm) foi verificada em todas as modalidades.

Conclusões

O viveirismo é um sector muito importante para o desenvolvimento da viticultura. Os resultados obtidos permitiram-nos fazer algumas considerações sobre os fatores estudados.

Entre os dois tipos de enxertia é certamente preferível o ómega que, além de proporcionar os melhores resultados, é também mais rápido e mais adequado para calibres menores.

Tendo em consideração os rendimentos no campo verifica-se que existe um efeito ligado à época de plantação; quanto mais tarde for feita a plantação menor será o rendimento em campo, desta forma, é necessário plantar mais cedo de forma a melhorar o rendimento.

A caracterização do calo de enxertia de uma forma sistemática, por meio de tecnologia moderna, forneceu resultados que devem ser investigados, considerando a variabilidade dos dados de acordo com as várias combinações de enxerto. Tendo em consideração o "barbatellone", este produto foi criado com o objetivo de propor aos viticultores um material de propagação inovador que reduz a variabilidade da vinha (com a substituição das falhas), facilitando a gestão da vinha durante o seu desenvolvimento, antecipando a primeira produção através da redução da fase não-produtiva da vinha, mantendo durante a plantação todas as estruturas de apoio de qualquer vinha existente e economizando nos custos de instalação. Estes estudos deverão ser prosseguidos de forma a aprofundar ainda mais os resultados obtidos, em particular, testar outras combinações de exertia e diferentes condições ambientais.

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INTRODUCTION

Italy is among the top wine producers in the world and among the sectors that make up the italian agro-food scale, shines with values constantly active, the wine industry. The reasons for this success are attributable to cultural tradition, rather than economic, which places our country at the top of world wine production.

The nursery business is the starting point for wine production, influence qualitatively and quantitatively all vintages production. The italian annual production of grafted vine and ungrafted vine is around 120-130 million. The share represented by grafted vines is increasing at the expense of ungrafted young vines whose prospects for production are rapidly deteriorating. Between 2007-08 and 2008-09 the production of ungrafted young vines is in fact past from 20 to 12 million and the decline will continue in the near future. During the same period the production of grafted is instead passed from 105 to 120 million. Italy has thus become the first producer of grafted vines to the world surpassing France, which reached only 105 million [Agronotizie.imagelinenetwork.com/vivaismo viticolo l'italia è leader nel mondo]. To provide the propagating material necessary for the renewal of the facilities of a viticulture which has about 600,000 hectares of vineyards, and support a consistent export, in the campaign 2012/2013 were produced more than 150 million grafts-cuttings and 9 million of cuttings of wild rootstock [Mannini, 2014].

In Sicily, the last five years (2005-2010) the production of rooted cuttings is more than halved, from 23,236,220 in 2005 to 9,887,429 in 2010, this fall in production has concerned the production of rooted cuttings while the production of grafted vines grew from 2,873,925 in 2005 to 3,686,429 in 2010 this turnaround is due to the advantages that the use of grafted vines involves.

The sector involves about 750 nurseries specialized on viticulture, 250 of which insist on the Sicilian regional territory [Istituto Sperimentale per la Viticoltura di Conegliano, 2003].

In Sicily, the last five years (2005-2010) the number of vine nurseries have been further reduced going from 175 in 2005 to 106 units in 2010. The area planted to rootstock mother plants (RMP), has decreased from 171 in in 2005 to 107 ha in 2010, while the area planted to graft mother plants (GMP) standard and certified has increased from 114 in 2005 to 127 in 2010.

The Italian vine nursery as well as a domestic market, enters even all right in the export of propagating material to third countries (approximately 18,000,000 grafts in 2013) [Mannini, 2014].

The objective of the nursery vine sector is and has been to produce a propagation material that meets the needs of growers that it is healthy from the point of view of health and is suitable for producing quality grapes for the entire production period of the vineyard.

The nursery vine has also worked to improve the product on the market, however, has almost always been taken into account the genetic improvement of sanitary cuttings through a weak clonal selection.

Very few are the studies related to the production processes in the nursery or the management techniques on the field with the intent to reduce if not eliminate the differences between the yields in post-forcing and yields in post-field and equally few researches there are on some graft disaffinity that directly affect these yields.

The innovation of vine nurseries international, national, but especially in those local and small, needs a scientific and technical support (as well as legislative) that propose new alternative strategies that can improve the production, which reduces the cost of managing and that aid in the production of the nursery material suitable for genetic improvement, but especially for quality viticulture and enology.

The aim of this research is to deepen the knowledge on certain aspects of the production process and some innovative products in the segment of grafted vines, focusing the attention on the techniques of grafting and forcing used in the vine nursery, on the period of planting of grafts-cuttings, and on some very innovative experimental techniques that are still under study. Furthermore, will also take into consideration the case of an innovative product in the marketing stage, which takes the name of "barbatellone", which aims to replace the failed areas in the vineyards and anticipate the entry into production of new vineyards.

1 PROPAGATION OF THE VINE

The propagation of the vine is the set of techniques designed to produce and spread in space, and maintain over time the species, varieties and rootstocks.

The creation of new vineyards or the upgrading of old unproductive or replacement of the vine varieties cultivated with varieties more responsive to market demands, require plants that, within the variety chosen, they must ensure a homogeneous behavior, in point of view both than that of vegetative development that productivity and quality factors. These factors rule out the possibility, on the part of the grower, of using the method of reproduction (gamico), since the results obtained are completely random and unpredictable, resulting in high heterozygosity in the genetic asset of the different varieties [Fregoni,1999].

1.1 Seed propagation or reproduction

The propagation by seed is used in the sector of genetic improvement, both to obtain new varieties from crossing that for obtaining hybrids for use as rootstocks, such as cultivar or as direct producers; but also for the study of the transmission of characters to offspring.

The seeds used can coming from free-fertilization, self-fertilization controlled, or artificial hetero fertilization. The subject of debate over the years has been the conception on germination of seed from hetero and self-fertilization.

The claim made by several authors [Fregoni, 1985 - Pastena, 1972] that seeds from hetero fertilization have a higher germination rate than those from self-fertilization, has been rejected by the tests carried out in our environment on inflorescences of four different cultivars of Vitis Vinifera (Regina bianca, Cardinal, Moscato d'Amburgo and incrocio Dalmasso VI-6). From a comparison of the characteristics of germination was observed variability due to different cultivars, but not between the groups self and hetero-fertilized.

Crescimanno et al. in 1981, starting from the consideration that the seedlings are generally virus free, they carried out a production tests of hybrids seedlings of American vines, to use as a rootstock for the European vines (Vitis Vinifera) [Crescimanno *et al,* 1984]. The use of these materials allowed the significant cost savings for what concerns the expense for the work of rehabilitation and maintenance of the health of the fields of mother plants, for the production cost reduced compared to the self-rooted cuttings and also proposed a genetic variability of great interest to carry out observations of agronomic, biological and plant pathology [Pastena , 1966].

Recently in the field of hybridization Italy has not made many studies; unlike France which, with regard to research on the production of hybrid producer, has a centuries-old tradition.

Even today at the University of Bordeaux, Montpellier, and Tolous are several research programs, using new molecular technologies in an attempt to insert into the genome of Vitis

Vinifera those genes for resistance to diseases of American species. Although the results of these studies are not definitive, the practical use of these O.G.M. is strongly hindered by socio-political impediments [Bavaresco, 2000 – Alleweldt *et al.*, 1988].

1.2 Vegetative propagation or multiplication

The multiplication is the form of propagation of the vines by means of vegetative parts, capable of emitting roots and shoots, and thus to give new plants. The multiplication gives rise to plants identical to the mother, as it perfectly preserve the morpho-physiological characteristics. It follows, therefore, the biological reality and agronomic of the clone, which is the population of plants, genetically uniform and continuous, deriving for exclusively agamic way from a single individual. The uniformity and continuity of the clone are interrupted by gemmary mutations (hereditary), which can be fixed, through the multiplication of the branch mutated, in a new clonal population [Pastena, 1990]. The asexual multiplication affects both rootstock and cultivars. Compared to the breeding, the multiplication offers two major advantages: get plants that do not have to overcome a long juvenile stage and can then begin to bear fruit very early; give rise to homogeneous progeny from a genetic perspective. In contrast, to the agamic lineages are transmitted any viral diseases of which the mother plants can be affected and this therefore requires the use of plant-healthy mothers [Baldini, 1986].
The multiplication can effectuated in three ways, gradually more complex:

- Offshoot
- cutting
- grafting

Grafting is a method of multiplication which consists in joining portions of different plants so as to constitute a single individual. In a grafted plant is distinguished therefore a part below the coupling point, said ipobionte, subject or rootstock, generally provided with roots, and an overlying, said epibionte, scion or object, intended to form the vegetation. In general, the grafted plants are bimember, that is obtained by the union of only two individuals; In viticulture, this mode of multiplication, has assumed great importance after the invasion of phylloxera. With the introduction of phylloxera the only way to defend the vines remained that of implanting the American vines on which to graft the European varieties [Baldini, 1986]. The advantages of this method of multiplication can be reached in viticulture are numerous:

- prevent pest attacks (phylloxera) with the use of resistant rootstocks;
- adapt the plants to different climatic and soil conditions, thanks to the specific characteristics of certain rootstocks that induce, for example, a greater resistance to drought, limestone, or even excess soil moisture etc.;
- regulate plant development, using rootstocks of different vigor;

- replace, by means of re-grafting, cultivars overcome by agronomic or commercial point of view. [Alleweldt *et al.*, 1988].

1.3 Micropropagation

Micropropagation is a technique of multiplication based on organogenetics totipotency of plant cells that consists of growing in vitro and on special substrates, isolated cells, more or less circumscribed portions of gemmari meristems, vegetative apex at the beginning of their development or small herbaceous cuttings with one bud (microcuttings). The interest against this asexual multiplication technique, derives from the multiplicity of objectives pursued with its application. The aims pursued are:

- multiplication of species characterized by an unsatisfactory rizogen attitude with conventional techniques of autorooting;
- Vegetative propagation by means of microcuttings of selected genotypes of new crossings, hybrids or clones;
- recovery from virus infection through thermotherapy in vitro, reducing the explants to a small portion of bud apex;
- conservation of the so-called "genetic resources" (germplasm), that is biotypes that tend to be eliminated from the culture while being custodians of some useful characters: these biotypes, usually collected in expensive collections or in camps catalog, can be kept in vitro, with a considerable economy of space and with reasonable cost limit. Such storage can be carried out at 5 ° C for one year, or at minus 196 ° C in liquid nitrogen for decidedly longer time;
- evaluation of biotic and abiotic resistance with the subsequent selection of resistant vines;
- genetic improvement, as the in vitro culture can be advantageously adopted to promote genetic variability (mutagenesis) exploiting the sensitivity of the gems to the mitoclastic action of the mutagen, especially physical;
- production of a large number of plants from a limited number of explants and therefore without the need to provide large areas of mother plants [Baldini, 1986].

Moreover, although the micropropagation technique of multiplication by now well-established, continue to appear in the scientific literature [Péros *et al*., 1998 – Torregrossa *et al.,* 1996] works aimed at a more thorough development of methodological procedures that affect the phases of proliferation of axillary buds and rooting [Vignevini, 2000].

2 PRODUCTION PROCESS

The young vine grafted derive from grafts at the table or machine cuttings of grapevine rootstock with scions of European vines. with the graft we get the so-called grafts-cuttings, which, subjected to forcing (to accomplish the grafting), are planted in the fields to obtain plants bi-membri. What we commonly call the vine nursery is nothing more than a definition that we apply to that set of structures that are involved in the production of young vine.

We can find in the market different types of nursery: from very small companies that produce few hundreds of thousands of cuttings per year, up to large companies or cooperatives that produce millions if not tens of millions of cuttings; a nursery that produces more than 1,000,000 annual young vine can be considered large.

however, is certain, there are some structures that can not miss in a nursery. In addition to the basic structures, such as those for the administration or for the conservation of fitosanitary product and equipment from work, a vine nursery absolutely must include: the premises for the storage of material to be grafted, the premises for the work of graft and other specific for forcing, we also include the fields (for the grafts-cuttings).

The different sizes of the vine nursery can easily respond to a problem of the large number of Italian grape varieties that are often grown only in certain regions if only in some provinces but, despite this, total production is concentrated on just a few varieties of wine grapes. Then: 10 varieties alone (Pinot Grigio, Sangiovese, Merlot, Moscato Bianco, Trebbiano, Chardonnay, Cataratto, Cabernet sauvignon, Glera, Barbera) occupy almost 50% of the area planted in Italy, and if we consider the top 30, they account for even 80% of Italian vineyards (out of 469 varieties registered!).

In addition, with regard to the availability of the clones, there is a marked disparity between the international varieties and typical of the area north-central, and the varieties typical of the south-central and insular for which the number of clones is still too low. For example, in the National Register of varieties are recorded 104 clones of Sangiovese, 40 of Merlot, 25 of Chardonnay , 37 of Nebbiolo, 25 of Barbera, but only 4 of Nero d'Avola (Calabrese), 4 of Grillo, none of Gaglioppo [Mannini, 2014].

Often nurseries smaller deal to supply precisely those growers who need variety more difficult to find on the market or that require small fees.

The biggest nursery instead prefer larger markets, national and international, working with large amounts of material to be grafted and therefore can not devote himself to the production of small quantities of cuttings, since the process would become too laborious and expensive.

2.1 Collection and preparation of wood for rootstocks

The material for the preparation of rootstocks is collected from the fields of breeding (Rootstock Mother Plants). The vines can be grown on supports or left free to crawl into the ground (*Creeping*) (Photo: 1, 2).

Photo 1: Creeping system

Photo 2: growth on support

The latter method in addition to being the most widely used, especially in the south, is also what allows for greater savings in material and workmanship for ligatures. The mother plants are grown in the “*testa di salice*" and, in November-January when it picks up the material, are left short stem rammed (Photo: 3, 4).

Photo 3: Mother plants before cutting

Photo 4: Mother plants field, after cutting

The branches removed should be well woody and rich in reserve substances (starch), starch is essential for the success of the grafts and the rooting of cuttings.

During the collection of the material used for rootstocks and for scions, as well as make sure that the material is fully mature, it is necessary to use certain small attention that will improve the final result that is the grafts percentage of successful:

- Do not pick up diseased grapevines, since, with the temperature and humidity of the room override any contamination would grow in an uncontrolled way and also contaminating the healthy wood.
- The cuts must be made with very sharp pruning shears and be net, without creating bottlenecks or causing lacerations.
- Be very careful in the determination of the variety, if appropriate, it is best to make measurements in the field when the screws are still in the process of vegetation (more ampelographic parameters).

After collecting the branches, they are tied into bundles and transported, taking care to avoid scraping, on the truck that will transport them to the nursery that will provide for storage.

Once you get to the nursery, the material for rootstock must be cleaned from the leaves, from the secondary shoots, by the tendrils, being careful to make cuts flush with the main axis of the shoot and eliminating the parties do not mature. So clean the branches can be kept in cold storage at a temperature of 2°-4°C, directly intact. The cold storage in the field nursery is very important since it allows to reduce the differences between the collection period of the material and the period in which it is used for the grafts.The cold storage serves to minimize dehydration of the wood, to avoid attacks of Botrytis and also to attenuate the metabolic activity that involves a loss of reserve material, important, for proper storage, is to maintain a good level of moisture in the cell in order to conserve water tissue. Becher (1971) for the storage recommend to cut the wood between 15 of December and 15 ofJanuary, then to treat the cuttings with a solution of Chinosol at 0.5% for 2-5 hours (up to 15 hours) and keep in climatized room at +1°C and 100% humidity; in the case where the relative humidity is below 90% the autor recommend to wrap the bundles of cuttings in plastic bags.

We must consider that the cold storage determine different results depending on the physiological time of withdrawal of the branches in the fields; In fact, the cuttings that have greater aptitude for conservation are those levied during the period at the end of dormancy and start the bud shooting [Pastena, 1990 - Eccher. *et al.*, 1971 - Liuni, 1972].

A few days before the commencement of the engagement, where the branches come from material collected previously and then cold stored, the branches are brought out of the cold chamber, allowed to acclimate for a few days and then begin cutting. The cutting of the vine generally takes place by hand, with the aid of pruning scissors sharp and a wooden stick for use as a "negative" for each cut. The wood to be used should have a diameter between 6-7 mm and 12 mm, if more up is little resistant during all the operations, contains few reserve substances and therefore will have low percentages of engraftment. The measure of the wood for the rootstocks goes between 15 and 50 cm (depending on the type of cuttings to be obtained), these are generally provided with three buds. The buds below the apical are blinded to favor the emission of the roots and to avoid that germinate during the forcing. During the preparation of the cuttings must be careful to observe the polarity of the cuttings. The cuttings thus prepared are divided into bands of 100 pieces each and immersed in water for a predetermined time before, and in a solution of water and anti-fungal then, with the objective to re-hydrate the material and eliminate any residual infection from the vineyard. In many parts of the world is now consolidated perform in this stage of production a hot water treatment called thermotherapy, which consists in the complete immersion of rootstocks (but also of scions) in water at 50°C for 30 minutes.

2.2 Collection and preparation of wood for the scions

The wood for the collection of scions is drawn from the pruned wood from some vineyards owned or known by the nurseryman. In this way it is the same nurseryman who select the best material for grafting, this is only possible for the "standard" material for which is expected to be the responsibility of the nursery the maintenance of health in the field of mother plants. The "certificate"material, which is also the one that provides greater purity and health of the material itself, however, can only be produced by using "base"material. The best material for a successful graft is what is freshly cut from the mother plants, in some cases this is not possible and therefore collects the material even before (December-January), but you should keep it with care just as described for rootstocks. In relation to the diameter of the scions from the opinions of the scholar are not converging: the Fabiani prefers to 6 mm and tolerates those of 5 and 8 mm, Vannucci want to 5-7 mm, Cosmo 8-12 mm, the Coceani of 7 mm and more, the Vicenzini from 8 mm to climb [Vannucci *et al.*, 1946 - Cosmo, 1938-1939 –Vicenzini, 1926].

The ideal situation would be one in which the diameters are as similar as possible between the rootstocks and scions (to facilitate the operations of grafting) and which is not smaller than 6 mm, since smaller diameters do not guarantee the minimum mechanical strength of the graft and the amount of reserve substances are very low. The scion cut and ready for graft should be about the size of 4 cm, by cutting the top with 1 cm margin and the lower part can be cut off in the middle of the internode. The scions thus prepared can be divided by variety, closed in bags of mesh media and cold stored together with the wood for rootstocks. Before grafting, the wood for the scions, is rehydrated and disinfected as the material of rootstocks, then the bags are opened scions divided into boxes and they too left to air dry.

2.3 Graft operation

The wood both for rootstocks that for scions, once it is dry enough is ready for grafting. The graft is kind of woody scion, grafting woody occur between two bionti that have woody texture. The most important woody grafts are:

- Whip (Innesto a doppio spacco inglese)
- Omega graft or multiple interlocking (Photo 5,6)

Photo 5: Example of omega graft

Photo 6: Example of multiple interlocking

The whip graft has been the technique of grafting at table for excellence, even today in some countries, such as South Africa, it is used with good results. Generally this type of coupling is carried out in the winter months (can also be done at home). The scion and the rootstock of the same caliber are chosen so as to coincide as much as possible the vascular bundles. The two bionti must first be cut with a oblique cut and then in the section doing a further cut along the axis of the timber that will allow the complementary union of the two parties; the latter are then held together by the strands of raffia, elastic or stapled together. This type of grafting requires that the grafter has some experience in the operations to be performed and which is also fast enough. This translates into a need for skilled labor that today it is not easy to find that led to the development of various semi-automatic grafting machines.

Today the use of grafting machines is not put into question, it increases the productivity of the workers, improves the uniformity of the grafts and the yields after forcing and after fields; a worker with a good practice of both methods can produce about 2000 grafts per day by hand using the technique of whip grafting while also gets to 4000-4500 grafts per day with a good grafting machine.

Today in the market there are several grafting machines that we can distinguish:

- machines for engagement with interlocking teeth (multiple joints);
- machines for V grafting or that simulates the whip grafting;
- machines for the cuttings with omega interlocking (Photo 7).


Photo 7: Omega graft machine

Each machine that can be used has advantages and disadvantages, at today the machines most used are those for the omega interlocking. The yield of these machines is always high and in any case depends on the skill of the operators. The machinery of the third kind (omega interlocking) allow for greater execution speed, but care must be taken in handling to prevent subsequent displacement of the graft that could compromise the engraftment [Pastena, 1960 - 1961].

The grafts omega interlocking and multiple are performed in the period from February to April, when scions and cuttings are in perfect rest. In each grafting machine works a person who selects the caliber of bionti and paying attention to the polarity of the two, making the graft with the aid of the machine; Optionally it is possible to operate two people by machine, a operator caliber the two parts and the other engages. The place where the operation of grafting takes place takes the name of “grafting site”.

The site of graft is a very important place in the production process must be lit, airy and easily washable surfaces. The layout of the graft tables must favor the lighting of the operators but also the movement of staff because, in addition to the grafter, you will need other people to supply continuously ready material to be grafted and the grafted material harvested from the crates and ready for the wax.

2.4 Waxing

The waxing is viewed positively, not only because it facilitates the grafting, but also because it eliminates in the nursery the cleaning, leading to higher spending. This operation, always carried out today, consists of dipping the grafts for about ten cm in paraffin, become liquid thanks to the waxing tub (machine provided with electrical resistors, which leads to the paraffin melting temperature of 60 to 72°C). On the market there are waxes and paraffins, added and not added with hormonal products and fungicides, which differ in composition, melting temperature and the role played [Pastena, 1990].

The traditional technique involves a triple waxing:

- The first, provided immediately after the graft allows the grafts-cutting to preserve longer the water content, the protection from infection with the addition of the fungicide, and the optimal healing of the coupling point through hormonal substances. As regards the content of hormonal substances, if excessive doses are added into the compound, more than 20%, sometimes enhanced excessively callus formation, with enlarged proportion of the same; while the best results are achieved with rootstocks that are characterized by poor shooting skills such as 157-11, 110 R, 140 Ru, 41 B, when the compound was added a greater quantity;
- The second, scheduled for planting the grafts-cuttings in the fields, is paramount on the ultimate success of the grafts-cuttings, especially in adverse conditions. This paraffin contains ossichinolina as fungicidal active ingredient, thereby prevents infections on the wood, on any points harmed and on the recently bud. Optimum is the use of paraffins with low temperature of immersion, in order to reduce sunburn bud and ensure the integrity and the ability to recover rapidly after implantation in the field;
- The third, scheduled for the definitive planting, provides for the protection of the same in the final transplant; This allows the protection from the weather and drying, the callus is being protected from mechanical actions and injuries and decreased the risk of fungal infections thanks to immediate formation of chlorophyll during bud break [Giornale di Viticoltura ed Enologia,1983.].

In some companies for waxing grafts-cuttings, and then only for the first two paraffinature, you can use a machine (Photo 8) that carries the grafts cuttings on a tape in which are positioned one behind the other the following devices: an injector of hot air that dries grafts cuttings, especially in the area of the graft; a device with nozzles that spray the wax into the desired part; finally, other nozzles with water at ambient temperature which cools the paraffin. At the end of the tape grafts are collected by two operators that will blend it into the boxes. The use of this machine is at issue, whether its purpose is to reduce the number of operators then it not

Photo 8: Particular of waxing machine

achieves its purpose. If talking about a technical resource that: if modern, well calibrated and well preserved especially, can reduce the amount of paraffin used for each graft by reducing the layer released without compromising the quality of the finished work.

2.5 Forcing of graft-cuttings

The forcing consists of subjecting the grafts-cutting in conditions of high temperature (25-35°C) and relative humidity, in order to expedite the completion of the graft, the formation of roots in the subject and the formation of the shoot from the bud.

The merit of invention of graft forcing can be traced back to Richter, who, probably around 1882, already knew the method, and as a manufacturing secret he tried to keep it hidden. Although the principle on which it is based (the callus graft scar is formed more rapidly at temperatures around 25-30°C) had already been enunciated by Verneuil in 1881, it is only after 1890 that, by Larvaron (1892) and Martineau (1893), he became aware of his technique. Already in 1899 they began to work in France with building big yards, which soon spread to Switzerland, Hungary and Australia. As for Italy, it seems that the first work on is due to M. Carlucci who performed in 1893 at the Wine School of Avellino evidence of grafting forcing in the moss. At this school he entered, the following year, in normal practice, forcing the grafts-cuttingf and already in 1905, when were creating anywhere yards of forcing, Ferrante discussed it with great expertise in the technical press [Giornale di Viticoltura ed Enologia, 1983.].

Photo 9: Box connected with pipe

The first yards of forcing their production based on the use of sand, both as a means for the conservation of subject and object both for the filling of the bins (or cassettes) of forcing. The next technical step consists in introducing the sawdust to almost completely replace the sand at all stages of the production process, if not for some preparations which still include. The use of sawdust has represented a breakthrough in the nursery industry because it has resulted in performance superior quality. Today in many vine nurseries is abandoning the use of sawdust at the benefit of the water. The sawdust is no longer needed for the cold storage, it is almost impossible to eliminate any source of inoculum even if it is well disinfected, and have also developed new techniques that allow the use of water, inside the chests, for forcing the grafts-cuttings, this technique has been called forcing in water. The technique of forcing in water consists in a series of steps that do not differ much from the forcing with sawdust. Like that, this need to be constantly followed by the nurseryman, who has the task of assessing their own means and their own results in order to plan the best technique strategy to use.

The grafts-cuttings waxed cuttings are placed vertically, with the part grafted upwards, within bins plastic material. The boxes contain about 4000 grafts and this is the best size that you can use: smaller bins would be easier to move and carry but would occupy too much space for the tare; larger chests are difficult to move, and if a problem occurs in one box there is a risk of losing a large number of grafts.

The boxes before being filled with grafts-cuttings should be well cleaned, checking for any remaining residue from previous forcing or other uses.

When you have available a sufficient number to fill the chamber forcing, these are placed inside the room used for this purpose and are connected between them through the pipes that connect them almost as the "electrical batteries" in series (photo 9, 10).

The boxes are arranged in series in turn connected with a tub placed inside the forcing chamber that will serve to provide the necessary water to the forcing itself. Each box is covered with a cloth dipped in a solution of water and antibotrytis.

Once the boxes are connected, we can fill with water from the cistern to an extent equal to the first 10 cm of the grafts-cuttings, once filled it can raise the temperature and the humidity of the room and begin the cycle forcing.

Today, it is accepted that increasing the temperature are greatly reduced times forcing, but it is preferable that the callus welding is formed slowly; the best results are obtained with temperatures gradually decreasing, namely:

- first 4 days 33°C and 95% R.H
- from the 4th to the 9th day 30°C and 95% R.H
- from the 10th to the 14th day of 28°C and 95% R.H.
- From the 15th day temperature and humidity are lowered by up to 17th-19th day in which they will more or less coincide with atmospheric temperatures.

Throughout the period of forcing is necessary that the water does not stagnate inside the boxes and that the lower part of rootstocks come in contact with fresh water and oxygen for the emission of roots, one of the possibilities to do this is to alternate every two days the presence or not of the water inside the boxes, (Photo 11). During the forcing cycle is necessary to check daily the status of the material inside the boxes, to perform around 3 treatments per week with antifungals to prevent attacks pathogens and also, at the time when more than 50% of the grafts cuttings is sprouted and has formed the callus is necessary to change the clothes on the boxes with other white lighter and they do move more air and light. Using this cycle of forcing do not require a room for greening and this is because the greening takes place right inside the room without moving the boxes containing grafts-cuttings. The nurseries that have available greening rooms may well, concluded the first 14 days of the cycle, leave the rooms for other grafts, and end the cycle in the specific rooms. In the greening rooms the grafts-cuttings undergoes a major transformation, which is the strengthens of shoot and hardens the callus, two key points for the success of the graft. Immediately after being passed under a canopy, where they are left for a few days, so that the grafts-cuttings can acclimate completely, and finally are subjected to a vigorous cutting of the shoots.

Since practice waxing and preservation of grafts-cuttings layered in cases of force in a environment with temperature controlled, the period of execution of the grafts is no longer a limiting condition the synchronization of callogenesi between object and the subject and the good distribution of callus on the sections of the two bionti. Callus formation is subjected to an endogenous rhythm and the period most favorable for woody grafts is between March and April. The callus formation is stimulated by endogenous hormones (auxins), produced in correspondence of the meristematic tissues of the bud. In the contact surface between the two bionti determines a division of the cells of exchange, not delayed by the practices of immersion in solutions of fungicides or bacteriostatic, followed by a hardening phase or differentiation of tissues with the formation of bundles conductors, which allow the vascular connection between the two bionti joined the graft. The anastomosis is indirect, unlike the herbaceous grafting, and is completed within one year from the graft; this hypothesis can be confirmed by histological observations. In fact, in the early stages of growth, the spread of the sap is not for continuity but by diffusion [Moretti *et al.*, 1992].

The factors that influence the formation and differentiation of tissues are different, namely:

- Physical factors: heat, oxygen, moisture, and light.
- Biochemical factors: endogenous rhythm of exchange closely related to the polarity of the gem, moisture, minerals, amino acids, enzymes and carbohydrates.

The availability of reserve substances has a significant role on callogenesis, and on the growth capacity of meristematic apexes; this has been proven by the research carried out by using scions to two buds of Cabernet sauvignon grafted on Richter 99 respectively 5 to 25 cm in length. So we can say that the entire structure of the rootstock contributes to callogenesi and, besides, it was possible to note the great importance of starchy substances and their metabolism during the evolution of this important physiological process [Hunter e*t al.*, 1996].

The callus formed between the two bionti can assume various dimensions, also voluminous due to:


Photo 10: Particular of connection between 2 boxes

- at different stages of functionality of the bud;
- the response to different types of grafting;
- to the different water content of the two bionti;
- the hormonal content of paraffin that you use.

From tests conducted using the cv Chasselas on rootstock Fercal and comparing three different dates of cutting the wood for rootstock and five different preservation techniques, it is noticed that the rates of engraftment vary greatly in relation to the date of cutting cuttings rather than in relation to the preservation method [Pastena, 1990].

Now that the forcing cycle is finished and the callus union between the two bionti is well-formed, or which involves the entire joint between the two parties, that is the right size and consistency that is solid and durable; you can proceed to the extraction of grafts-cuttings from the boxes and this operation takes the name of “un-boxing".

The boxes are rotated on the larger side with the opening on one side and at this point, very

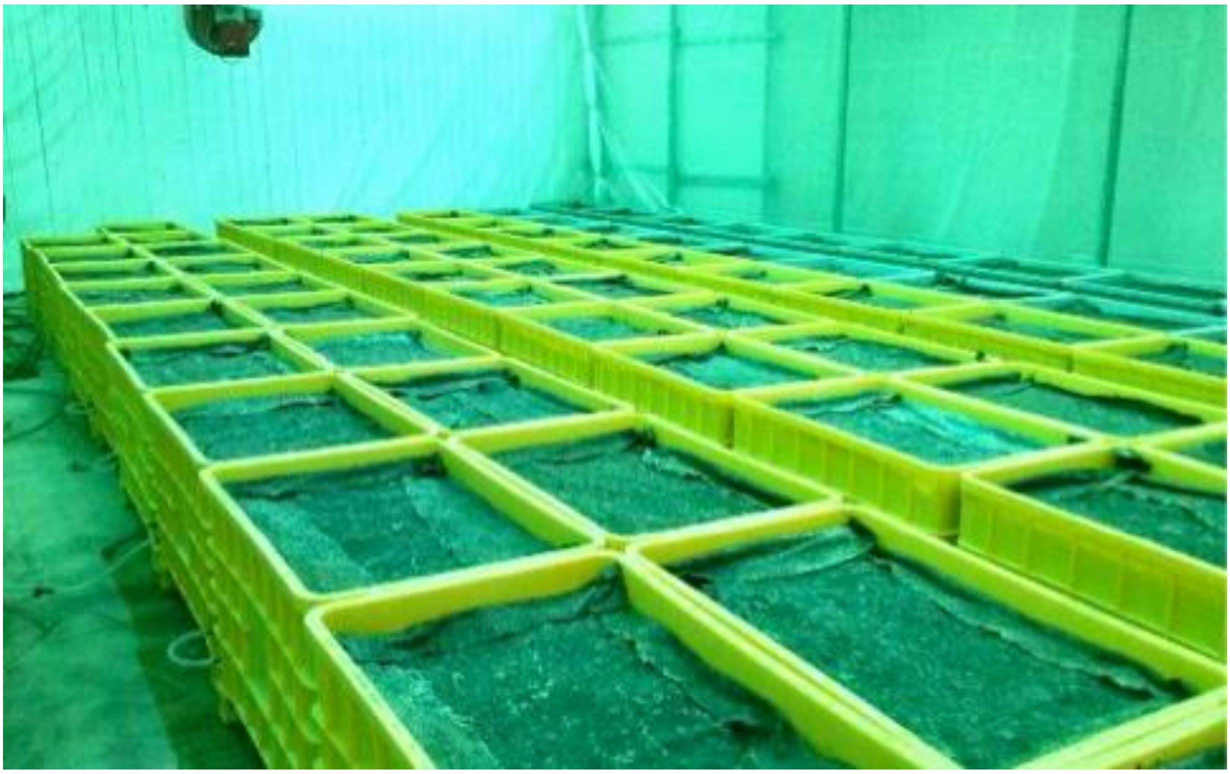
Photo 11: Forcing chamber on working

carefully and gently by the operator is pulled away on one side the grafts-cuttings. The material thus free from container needs to be taken in hand by the operator that the inspection and it removes any rootlets and shortens the shoot with one or two buds. Grafts-cuttings at this point can waxing and are placed in containers which will be used to transport and at the bottom is poured a solution of water, rizogen hormones and copper sulphate, this solution has the purpose to maintain hydrated the cuttings and stimulate the emission of roots.

2.6 Plant on the field

The grafts-cuttings forced and waxed can be implanted in the field to get young vine grafted. A good soil, in which to implant the grafts-cuttings, is without doubt, one of the reasons for getting high yields. The land for the nursery must be flat, of medium-textured tending to loose, fertile, poor limestone, sufficiently cool and at least to the south, irrigable.

In the South and in the islands can not grow in the dry, seen in some years trending of drought, it is necessary to perform a large number of irrigations, even on a weekly basis, from April to September. Irrigation can be carried out using different methods, namely: sprinkler irrigation (Photo 12), through the use of perforated pipes (hoses) or, lately, with the use of a wing dripping (Photo 13), with nozzles incorporated at different distances and variable flow (4 to 10 liters per hour); this new methodology allows both a greater uniformity of irrigation and especially the possibility to fully automate irrigation, with the use of devices in time, and of solenoid valves. Implant grafts-cuttings on mulched embankments as well as being among the most widely used techniques is also one that allows you to get the best results.

Photo 12: Sprinkler irrigation

The soil must be subjected to rotation, so it rest, for a suitable period of time (2-3 years) variable according to the characteristics of the soil itself, before repeating the same cultivation. The "fatigue" of cultivation has reflected more or less negative in terms of percentages of engraftment, development of grafts-cuttings and health status of the same. In the case where the propagating material obtained from a certain field showing affection from virus infection, then it is necessary to abandon the field for at least 6-7 years, so that the land is healed naturally; in

Photo 13: Irrigation with wing dripping

fact the culture repeated in a time interval of less than 6-7 years aggravates the virus diseases since these are conserved in the soil and multiply on numerous residues of the roots, who are still the reproductive rhythm of nematode Xiphinema index (vectors of viruses).In the years of "rest", the land must be cultivated regularly, preferably with graminaceae, which accelerate the process of elimination of toxic products and crop residues left by the cuttings. During the summer, the ground should be subjected to deep plowing, at least 60-70 cm deep [Pastena, 1990].

For the fertilization is fundamental know the natural endowment of mineral elements in the soil and the extent of removal by plants; on this knowledge is based the contributions of fertilizer for the soil.

However, given the particular nature of the cultivation, must perform abundant fertilization, so that the roots of the grafts-cuttings are largely in contact with the nutrients of the soil. Positive, in respect of the performance, are also mixtures of foliar fertilization with macro and micro elements (such as Mn+NPK, B+NPK). The plantation of grafts-cuttings is done in rows, the mulching is predrilled at the points where they will be inserted the graft-cuttings so just to be driven into the ground, being careful not to break them. The cultivation care to be performed are the weeding, which have the purpose of maintaining a soft surface layer of the ground and eliminate weeds, which evade the seedlings not only the water and nutritive salts, but also and above all the light. The number of sarchiature varies in relation to the needs presented by the land and, in any case, must be timely, assiduous and accurate. In order to avoid all or part of the sarchiature, we resort to chemical weed control in pre-emergency and before the budding. It should then: make 1-2 irrigations in northern Italy, but in warmer areas of central-southern is essential to the normal watering to once a week; In addition, perform a variety of treatments with products based on copper and sulfur to control powdery mildew and downy mildew attacks which are susceptible scions and make some toppings in green, in order to remove some of the vegetation to facilitate the passage of tractors with machines operators and to allow an enlargement of the diameter of the young vine. Following the fall of the leaves, we proceed grubbing rooted grafts; Today this is done with the machine. After being examined the welding, which should be sufficient, regular and secure, are subjected to the "toilet", that is, the bud pruning and removal of threadlike roots on internodes; are classified, then, according to the development of the roots mainly in two qualities, keeping in mind that the law (D.P.R. 24 dicembre 1969 n° 1164) states that the roots must be at least three and well developed and spaced, but that for the combinations with the rootstock 420A can have only two roots well developed and in opposite position.

Following the classification, the young vine will be subject to the third waxing, counting, wrapping, storage and eventual commercialization [Pastena, 1990].

3 ISSUES OF THE NURSERY

It is clear to all that the nursery industry plays a pivotal role in the wine industry; fight and solve many nurserymen's problems simplify cascading work in the rest of the chain.

Common issues to many sector to, and not indifferent also in the nursery sector is the poor and often inadequate legislation over that from the point of view of the health of the material, also as technical assistance to the nurseryman. Also, very difficult in the field of vine nursery, is the entry of new companies within the same industry often bring innovation and competition among the companies and promoting the development of the entire sector. This difficulty is due to several factors such as the need of high initial capital, low income during the first years of operation, the difficulty in finding workers with a certain degree of specialization, the inclusion of the product in a market that often works with commission.

As we have already mentioned the problems of the nursery are not only social-economic and most often the real issues that must be addressed in the nursery belong to the realm of technique.Several authors have tried to confront diverse issues especially those concerning some graft disaffinity and in the case of northern Italy, the last few years there have been numerous studies that have investigated about some diseases (flavescenza dorata, Black wood deases and esca deases) that represent a real plague at nowadays for viticulture Italian and International. Another important problem for the nursery are the yields in the fields. From research in the sector and personal observations it's possible to see that when the nurseryman ends the forcing process of grafts-cuttings and leaves the material from the bins, making a count and calculating the percentage of success is generally known that the yields after forcing are very high and at times very close to 100%. If the nursery was able to maintain the same rate of success in the fields would definitely be a success; instead what usually happens is that the yields in the fields are lower by several percentage points. The decline in yields in the fields is the result of a combination of several negative factors (climate, technical, management) that cumulatively lead to the death of many graft-cuttings.

3.1 Health of propagation material

The possibility of contamination during the production process are manifold from the fields of mother plants and continuing with the process of propagation, conservation and plantation in the field and in the vineyard. The first attention should be placed to the fields of Plants Mothers (PM), where there are materials of different categories (standard, certificate, base) that have different levels health, because coming or produced by clonal selection protocols and health non-uniform.Some of these problems, especially obtain and distribute healthy material can not be attributed only to mistakes or bad work of the nursery but would require legislation that in recent years has been quite poor with regard to the particulars of the viruses considered harmful, the Community regulation is bad, slightly better Italian ones for the insertion of the GVA in addition to GFLV, Ar-MV, GLRaV1 and GLRaV3, whose presence in the reproductive material prevents the commercialization [Malossini, 2006].

New technologies in the field of pathology useful today allow you to detect the presence of the pathogen with more timely manner than in the past but mostly with very low concentrations of the pathogen in plant tissues. Molecular techniques such as A.P.C.R. that, although expensive, allows to obtain results that with other tests would not achieved. The test that is most often used in nursery is the ELISA test that it does not allow the identification of phytoplasm that are now one of the problems of Italian viticulture especially in the north of Italy.

Remarkable innovations are the experiences of hot water treatment of nursery material (graft-cuttings in particular) to contain one of the most dangerous and widespread phytoplasma diseases of the vine, the (flavescenza dorata). The hot water treatment is known as one of the most economical, practical and effective that allow the control of numerous endogenous and exogenous pathogens both in cuttings and in the young vine. The hot water treatment can be performed before the formation of callus or before sale to the grower, generally, the nurseries prefer to adopt this practice before the formation of callus because it is seen that there is a certain mortality of the material subject to this practice it is preferable to control this mortality in nursery and prevent it from occurring after implantation by the grower. Nursery industry today, there are no practical alternatives to the treatment with hot water for large quantities of material; the control of endogenous pathogens is very difficult by the normal techniques which act only on the outer surface of the material without being able to enter the tissues phloem and xylem and control the pathogens located in these tissues. However HWT of cuttings or young rooted vines at 50°C for 30 min. is regarded as an effective control of endogenous pathogens, including *Agrobacterium vitis*, *Phaeomoniella clamydospora,* the primary invader in esca heart rot, and the phytoplasma Flavescence dorée since the heat is able to completely penetrate the wood, killing the pathogens, but not the marginally less sensitive vine tissue. Hot water treatment is also an effective control for external pests including nematodes and phylloxera. For what concerns the timing to perform the treatment with hot water, some Australian companies have noted that the material concerned by the treatment with hot water after the cold storage results to be of poorer quality than the material in which the treatment was performed before of cold storage [Wait *et al*., 2005].

Often the hot water treatment has been the scapegoat in many cases of mortality of the material to be grafted or grafted; it is really very difficult, however, to separate the hot water treatment from other possible causes of mortality and often more depth investigations have revealed that the real cause of death was, during the propagation and planting, the cumulative effect of many small problems. At today, the treatment with hot water is the only one that satisfactory results although unfortunately consists in a shock strong enough for the plant that may not even be able to resist; until there will be other techniques which allow to obtain equal or better results, to obtain cuttings of quality, treatment with hot water, is surely to be included in the production process. In the sector of health material were carried out several studies that aimed to create in the laboratory, through systems controlled hybridization, varieties resistant to the most common pathogens such as powdery mildew, downy mildew and botrytis. The more research in this area come from France, which has a centuries-old history in the context of hybridization and in the field of creation of resistant varieties. Today, however, there are no varieties resistant to diseases very harmful as the fitoplasmosys.

These diseases are ravaging the vineyards of northern Italy, but the causes of these problems are not to be found exclusively in the propagation material but especially in the management of the vineyards that, given the current economic crisis, more and more frequently are abandoned to their fate, making these abandoned vineyards in outbreaks difficult to detect, which is necessary in this sense is a law regulating more accurately the management and maintenance of the health conditions of the vineyards.

3.2 Yields in the fields

Many nurseries, especially small ones work for commission, which leaves them with only prepare the material that will sell the following year. It then becomes important at this point to know what are the success rates of the graft in order to prepare the correct amount of material to use in the season.

Predicting yields after forcing and after fields is not easy, in addition to events that are known to lower yields (errors during the stages of production, disaffinity grafting…) unexpected events may occur that could seriously affect yields: attack pathogens which if not controlled properly can take epidemic proportions in the nursery, adverse climatic events which in the fields drastically reduce the percentage of engraftment. Today does not exist in this sector machinery or methods to understand in advance if the graft will be successful or not, but, they are studying and some methods are under development that can aid to the experience, which is essential, of the nurseryman. Technological innovation in nursery industry unfortunately is not as forward in time, probably in a not too distant future we will see the implementation of machines that selects automatically the grafts-cuttings to carry to the fields or others that automatically perform the grafts and select the caliber of the two parties.

4 PROCESS INNOVATIONS

It is not easy find in the more modern bibliography works that speak in depth about the techniques of forcing or machines that can be used in the entire production process (graft machines, blind machines, machines for hot water treatment and others). In this work have been highlighted those techniques or those innovative technical means that can aid in the nursery.

4.1 Forcing in water

One of the most important processes in the production of young vine is the forcing of the graft-cuttings. The practice was most commonly used, and is often still used in some countries or in smaller nurseries, consist to insert the grafts-cuttings, just grafted, inside wooden boxes filled with sawdust; the boxes are then placed in a chamber at 30°C and 85-90% R.H. for the first few days, then the temperature and the humidity are lowered over a period of 10-12 days and finally the boxes are brought in the rooms of greening for another week. The grafts-cuttings thus prepared are then subjected to toppings, unpacking, cleaned of sawdust and roots, pruned to 1 or 2 buds, waxed and then brought in the field to be implanted. The use of sawdust in the process was also justified because many nurseries preserved, even for a few years, the grafts-cuttings, after the callus chamber, inside the forcing boxes and storage in the cold rooms. The sawdust is a good thermal insulator and helps to avoid thermal shock during the callogenesi, by contrast, it is difficult to make sterile, although it is also sterilized using different products may recur, however, symptoms of botrytis, it is also expensive and not easy find good sawdust on the market.

The best alternative that in recent years has increasingly developed is the technique of forcing in water. The grafts-cuttings, once plugged in and paraffin are placed inside plastic boxes previously adapted for this purpose. The adaptation consists in the creation of two holes for the connection between the boxes and a hole for draining water. The best boxes have intermediate measures because they allow better handling of movement and do not run the risk, if something were to go wrong, to lose too many grafts-cuttings, a capacity of 4000 grafts is the best measure suitable for this purpose.

The filled boxes are covered with a cloth quite often and brought inside the chamber forcing, which at this time is not air conditioned, to fill it. The boxes within the chamber forcing must now be connected between them with the appropriate tubes and the hole for the outflow of the water should be closed. Once the boxes are connected, we can fill with water from the cistern to an extent equal to the first 10 cm of the grafts-cuttings. With the chamber filled, and the boxes connected and filled it can operate the heating system which consists of a heater and a humidification plant, where temperature and humidity are adjusted by means of thermo-hygro-stabilizers. The distribution of hot air output from the heat generator is achieved by a sheath of transparent plastic film with holes, necessary to ensure a uniform heat distribution over the entire surface of the forcing chamber. Today, it is accepted that increasing the temperature are greatly reduced the forcing times, but it is preferable that the callus welding is formed slowly; the best results are obtained with temperatures gradually decreasing, namely:

- first 4 days 33°C and 95% R.H
- from the 4th to the 9th day 30°C and 95% R.H
- from the 10th to the 14th day of 28°C and 95% R.H.
- From the 15th day temperature and humidity are lowered by up to 17th-19th day in which they will more or less coincide with atmospheric temperatures.

The water inside the caissons must be stop alternately every two days then two days with and two days without water, and then again, this process must continue throughout the period of the forcing. The water to be used should not be stagnant and needs to be about the same temperature that we find in the room, so just put in the same room a large container containing the water to be used during the forcing.

The process of alternating the presence of water has several purposes, improve oxygenation of the basal parts, avoid water stagnation within the bins and have clean water every two days. During the forcing cycle is necessary to check daily the status of the material inside the boxes, to perform around 3 treatments per week with antifungals to prevent attacks pathogens and also, at the time when more than 50% of the grafts cuttings is sprouted and has formed the callus is necessary to change the clothes on the boxes with other white lighter and they do move more air and light. When the cycle is finished, the bins can be placed under a roof for a couple of days in order to acclimatize and proceeds normally with the production process. The method of forcing in water has several advantages for the nurseryman, which however must always keep under control the process is examining the material, either by direct action, but also by changing the method according to the needs of the individual nursery. In general, this technique allows to significantly reduce the costs of the nursery (better management of space in the callus chamber, saving on the purchase of sawdust and products used for the disinfection), decrease time to forcing, facilitate the work in the nursery and reduce the environmental impact.

4.2 Yields after planting

A very important problem in the nursery sector is to reach the highest level of yields both after forcing, that after yields in the fields, nurseries often achieve high yields after forcing, but often the high yields obtained include grafts-cuttings failed that are implanted without any certainty that callus is really well done. This is because the choice of what grafts-cuttings to bring in the field, falls exclusively on the nurseryman and his experience, unfortunately, all this results in yields after the fields hovering around 70%. Going to closely observe the young vine not taken root in many cases it can be seen as the young vines have died immediately after implantation or even have not even started growing after planting. The failure growing of vines in the field, in addition to being a waste of storage space, fertilizers and farming operations, it is also difficult to predict and this is because very often the cause can be environmental. Added to this is, that very few have been trials involving management techniques in the nursery and in barbatellaio to reduce the high spreads between yields after forcing and after fields (although there would be mentioned some studies conducted in 1908 by Paulsen and Gibertini on the set of forcing and mechanical graft of the American vines, of which there have been few insights developed below). In this ambit enter the thesis work that continued the research started in 2010 by the Dipartimento di Colture arbore dell'Università di Palermo to identify the influence of the time of implantation on the yields after fields, but also the use of techniques standardized and automatable if the case for the productive improvement of the efficency in the field. In particular, we will analyze two techniques for checking the quality of the graft in post-forcing and success in post-fields. The first concerns the coloring of the callus at the time where it exits from the forcing chamber through the aid of a colorimeter and the second is the method that thermographic measurement, by a thermal camera, measure the heating and cooling transient of grafts-cuttings to following exposure to a uniform source of heat, assuming that a uniform exchange process, also in correspondence of the zone of coupling, it may be an indication of a successful vascular connection between two bionti.

5 PRODUCT INNOVATION

The task of the nursery is to provide the material for the implant to the grower. Responsibilities of the nurseryman is that the material corresponds to the combination of graft and request that it is healthy material within the limits of the law. today, in the economic system that integrates the nursery company must meet certain market forces that lead to tackle problems of competition between businesses (even at the level national and international), using suitable marketing strategies, innovate the production process and the product offered. For product innovation offered means the marketing of propagating material for the grower, who can answer and solve certain problems and needs of the grower himself.

Dead vines are often a problem present in many vineyards and are due to physiological or pathological causes (Andreini et al., 2014) whereby the vines need to be replaced. The replacement operation is a real cost due to the direct costs of the plant material, for its planting and for their different management during the current year or in the two years after replacement, replacement also affect vineyard variability. The vine replacement is quite easy in the first two years after vineyard establishment, but many issues occur when it is later, especially due to the root competition with older vines. It is well known that root growth and exploration can affect vegetative and reproductive parameters (Champagnol, 1984 - Fregoni, 2013). The root system is partially built in the nursery and, obviously, is affected by nursery management (in-row and inter-row distances, irrigation, etc.). Vineyard uniformity can also be supported doing

- accurate plant material selection;
- correct vineyard establishment and management practices;
- accurate vine replacement close to vineyard establishment (Pisciotta *et al*., 2013).

The aim of this part of the trial was to create alternative nursery propagation material for replacement the dead vines in the vineyard, improve the vineyard uniformity, synchronize the vineyard management practices during the first two years of plantation, and to anticipate the first harvest.

6 MATERIALS AND METHODS

The thesis work was aimed to investigate and implement the knowledge in the nursery so that you can develop a more innovative approach on the possible management of the nursery and of the field. In particular the tests has involved two techniques of forcing (water and sawdust), two different epochs for the implantation in the field, two innovative techniques for the analysis of grafts-cuttings before the implantation in the field and an alternative product named "barbatellone "that can be helped the grower during implantation and in subsequent early years.

All the tests performed in this work were carried out at the nursery Mannone Petrosino (TP) and the material used was of type clonal and standard. For the production of young vine, the company Mannone makes use of rootstocks (cuttings about 40 cm long) that come both from the fields of rootstock mother plants owned by the company both acquired by other Italian companies. The rootstocks used are certified (marked with blue label) and come from the base propagating material. The material used for the preparation of grafts-cuttings in part derives from Fields of Scions Mother Plant owned by the nursery and in part (standard propagating material marked with dark yellow label) was obtained from the branches of pruning of vineyards in production belonging to the company "nurseries Mannone" but also from vineyards owned by others. These vineyards are based on variety of which is established the identity and varietal purity and this material is subject only to the negative massal selection; is authorized camps set up by the entities involved in these tasks; in the case of the company in question controls said fields are conducted by technicians headed by the Assessorato Regionale Agricoltura e Foreste and Ispettorato Provinciale dell'Agricoltura of Trapani.

The propagating material, once collected from the fields of mother plants is brought in the nursery, here is hydrated for some hours (about 6, in function of the water status of the material) and is subsequently placed in a solution of antifungal and water, in this will combine the action of antibotrytis, against the development of pathogens on reserve substances of the wood, and water which dilutes inhibitors such as abscisic acid. In this case, but as often happens in the nursery, the material for the tests was collected in advance of the period devoted to the preparation of grafts-cuttings. Thus, the hydrated material was refrigerator-preserved (T +2°C /+4°C, RH> 90%) and, once are ready to start the grafts, is rehydrated for 3 hours (hydration preinnesto) and then immersed in a solution with antibotrytis for 1 hour.

The material already cut to the appropriate size and intended for the preparation of rootstocks, is blinded by a machine (Photo 14) equipped with brushes that scarify the area of the buds, blinding or otherwise inactivating.

Once the material is a little bit more dry, has been made the graft (Photo 15) at the table using a machine that makes the coupling with interlocking omega. Finished the graft, has been made the first waxing (Photo 16) that interests approximately the top 10 cm of the grafts-cuttings, this practice is by immersion of the grafts-cuttings in a solution containing wax (liquid status), hormones and fungicides, the melting point of the paraffin is between 58 and 75 ° C and, in this case, the color is red.

The grafts-cuttings waxed are ready for the forcing chamber, in the tests carried out for this work were used two types of different forcing: forcing with sawdust and forcing in water and in the description of each test will be specified the type of forcing being used. In both cases the process of forcing consists in placing the grafts cuttings in conditions of high temperatures (20-35°C) and relative humidity (90-95%), so as to accelerate the processes histogenetic and the engraftment of the graft.

In the case of the forcing with sawdust: grafts-cuttings are placed in the rectangular container without cover and with a movable side; the boxes can be used in wood or resin, rectangular and square and take the name of "boxes forcing", respectively, with dimensions of approximately 100 x 60 x 60 and 120 x 120 x 60 and able to contain a variable number graft-cuttings (1,400 to 1,800 for the wooden boxes - from 3,000 to 3,800 for the resin boxes) according to the diameter of the same. The graft cuttings are placed in these boxes and layered with insulating material (in the experiment was used sawdust of fir), and finally conveyed into the chamber forcing (temperature: 20-40°C - Relative humidity> 85%) in such a way, as mentioned, to accelerate and facilitate the welding of the graft. For the loading of the grafts-cuttings in the boxes, shall have it the open side facing the operator and the mobile side facing up, then you work by putting the filling on the bottom of a first layer of insulating material of 6-10 cm in height and are placed horizontally on the floor the grafts-cuttings, with the graft facing at the open of the boxes and the base about 10 cm from the bottom.

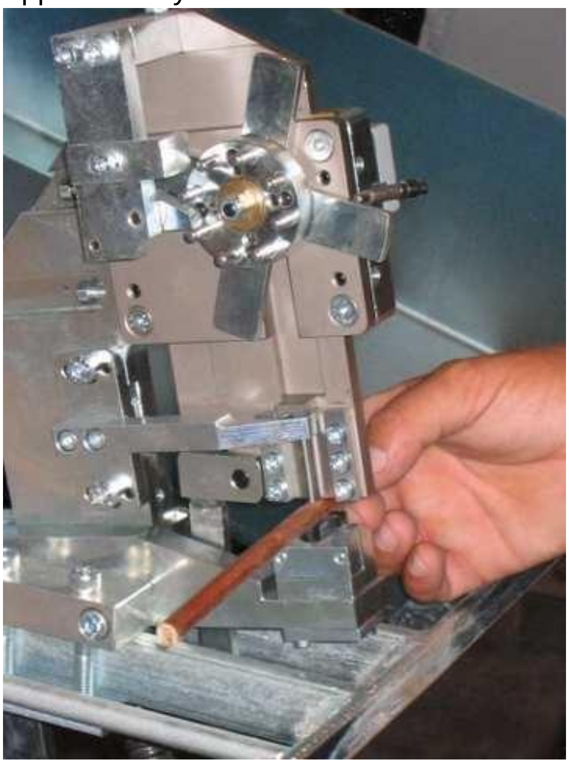

Photo 14: Machine for blind the grafts-cuttings.

Following the chest is closed and placed with open mouth at the top, so as to respect the polarity of the grafts-cuttings and facilitate the down outflow of hormones. Is distributed sawdust over the scions to maintain optimal humidity levels. In order to maintain a high rate of moisture inside the boxes, especially during the storage phase pre-forcing, the chest are wrapped with black plastic film (polyethylene) and cellophane. (Photo 17).

Photo 14: Blind machine

Once ready, the boxes are placed in the chamber forcing equipped with stove and humidification system, where temperature and humidity are controlled by means of thermo-hygro-stabilizers (Photo 18)
. The distribution of hot air output from the heat generator is carried out by a sheath of transparent plastic film with holes, necessary to ensure a uniform heat distribution over the entire surface of the chamber forcing. The forcing lasts on average 15 to 18 days. The temperatures used are:

Photo 15: Omega graft machine

- The first two days, 40°C;

- From the third to the eighth day, gradually decreasing from 30 to 24°C;

- From the ninth day, gradually decreasing from 24 to 20 ° C.

The relative humidity is maintained close to 90%. After a few days of forcing, as a result of germination, treatments are carried out every three days with antifungal against gray mold and also have been practiced frequently topping (2 or 3) to avoid the excessive development of the shoots before the formation of roots. At the end of forcing, the boxes are transferred for 6-

Photo 16: Waxing of grafts-cuttings

10 days, in the "greening room or hardening room", illuminated and at environment temperature, so that the grafts harden the callus and the shoot. Finished acclimatization, we proceed to the “un-boxing”. The boxes containing the grafts forced cuttings are placed with the uncovered side facing the operator and the moving wall at the top; is removed the first layer of sawdust and after extraction gl'innesti-cuttings, making a forceful topping of the shoots. Then we proceed to carefully separate the grafts-cutting, taking care not to cause separation of the scions from the subjects, cleaning from sawdust and cut any small roots formed. At this point one can proceed with the second wax that precedes the implant in barbatellaio.

Photo 17: Resin box cover with plastic film

In the case of forcing are used in cases in resin or plastic material without cover measures 57.5 X 52.5 X 93.5 cm that can hold about 4000 grafts cuttings each. The grafts-cuttings are inserted into the bins so as to leave practically no space between them, while maintaining the polarity and are covered with a cloth in order to maintain as uniform as possible inside the tank, the temperature and humidity. Once filled, the boxes can be placed in the callus chamber where they are connected to each other and with a container through appropriate plastic piping, and then proceeds to fill the bins with water to approximately 15 cm depth. Once ready, the boxes are placed in the chamber forcing equipped with stove and humidification system, where temperature and humidity are controlled by means of thermo-hygro-stabilizers. The distribution of hot air output from the heat generator is carried out by a sheath of transparent plastic film with holes, necessary to ensure a uniform heat distribution over the entire surface

of the chamber forcing.
The forcing lasts about 15 days and the temperatures used are:

- first 4 days 33°C and 95% UMD
- from the 4th to the 9th day 30°C and 95% UMD
- from the 10th to the 14th day of 28°C and 95% UMD
- From 15th day temperature and humidity are lowered by to 17th-19th day, until to arrive to the atmospheric parameters.

The water inside the caissons must be stop alternately every two days then two days with and two days without water, and then again, this process must continue throughout the period of the forcing. The water to be used should not be stagnant and needs to be about the same temperature that we find in the room, so just put in the same room a large container containing the water to be used during the forcing.
The process of alternating the presence of water has several purposes, improve oxygenation of the basal parts, avoid water stagnation within the bins and have clean water every two days. During the forcing cycle is necessary to check daily the status of the material inside the boxes, to perform around 3 treatments per week with antifungals to prevent attacks pathogens and also, at the time when more than 50% of the grafts cuttings is sprouted and has formed the callus is necessary to change the clothes on the boxes with other white lighter and they do move more air and light. When the cycle is finished, the bins can be placed under a roof for a couple of days in order to acclimatize and proceeds normally with the production process. After acclimatization, the grafts-cuttings was been cleaned the parts not useful, such as roots and shoots too long, pruned to one or two buds then paraffin-embedded. The operations of waxing, as all subsequent ones, are identical for all grafts-cuttings, these come from forcing with sawdust or forcing in water. The second waxing (Photo 19, 20) use a paraffin flakes with high melting point (80-85°C) with the aim of resist in the field and avoid degradation. The amount of paraffin used is 4-5 Kg/1000 grafts.
As soon as paraffin, grafts-cuttings are placed in the plastic baskets and taken outdoors where they remain until the implant but no more than 3-4 days. Once this phase the grafts-cuttings are ready for planting. The implant graft-cutting is carried out in the field, on the ridge mulched with black PVC sheet, and the cultivation technique followed is the one used by the growers in the area.
Even in the field, the conduction of grafts-cuttings, is the ordinary one used by nurseries in the area; in particular during the vegetative phase are carried out topping operations (3-4 in the

Photo 18: Hot system for the forcing chamber

growing season), and weekly calendar treatments with fungicides. After the fall of the leaves, making the eradication of young vine; and then measured the yields, sharing the young vine in those first choice and the second choice. This division is made considering some biometric characters such as:

- Length, number and distribution of the roots;
- presence and development of shoots (according to the legislation n° 1164, of 1969).

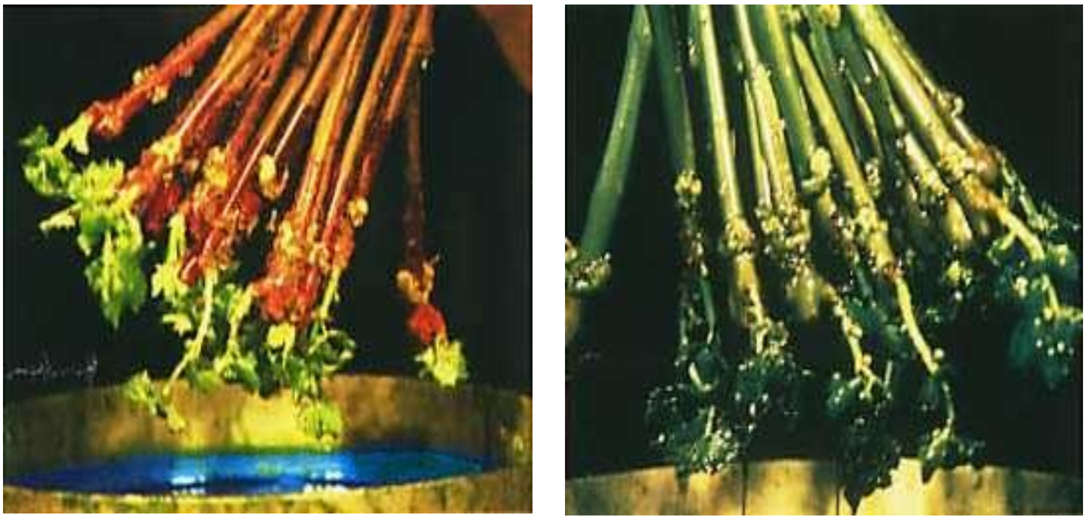

Photo 19, 20: Grafts-cuttings before and after second waxing

Finally, it is making the third waxing for the conservation of young vine necessary for the plant. Then we proceeded to set the experimental activity itself, which has involved the study of various aspects of the production phase of the young vine both in forcing that in the fields, and in particular:

- type of forcing
- period of plantation
- coloring of the callus
- Try thermographic
- Barbatelloni

As mentioned, the tests carried out have focused on the study of some factors and techniques that affect the production of grafted.

The tests carried out are summarized in:

A)Test relating to the management of the nursery and of the fields and effects on the characteristics of grafts-cutting products and yields in the fields.

B)Test relating to the production of an alternative product to enter in the market (barbatellone).

A)Test relating to the management of the nursery and of the fields and effects on the characteristics of grafts-cutting products and yields in the fields.

6.1 Test A1: Study of two different techniques of forcing and two grafting techniques and effects on yield and quality of rooted cuttings.

The test was carried out in the 2014 season and had the objective of verifying between the two type of forcing (water and sawdust), and the technique that produces the best results, both in terms of yield on the fields, that in terms of size callus and distribution of roots. In the nursery were prepared two boxes containing 4000 graft-cuttings each, 2000 by type of graft (omega or multiple interlocking). Each box has followed a different method of forcing (water or sawdust). The results were studied on a single combination of grafting (Catarratto/1103P) as this, even in the opinion of the nurseryman, is one of the most used in Sicily, it has also chosen to use these two types of graft because, omega interlocking is the most common, while the interlocking method could be an alternative. During the trial have been set thus thesis 4 (2 forcing techniques - 2 types of graft). The temperature and humidity inside the forcing chamber, during the research period were controlled by sensors that are generally used in the nursery, were also monitored through with other sensors temperature and humidity inside the boxes in the forcing chamber. Also for the entire period that the plants have spent in the field were collected climate data. In the fields the conduction of grafts-cuttings, is the ordinary one used by businesses in the area, especially during the vegetative phase were carried calendar weekly treatments with fungicides.

For each thesis, furthermore, were created 5 sub samples each consisting of 20 grafts-cuttings. For each sub-sample was determined the percentage of engraftment. Obtained the percentages for each treatment, we proceeded to the angular transformation of the data ($Y = \arcsin \sqrt{P/100}$), where P is the percentage of sub sample. On the data thus obtained we proceeded to the analysis of variance to assess the significance of the sources of variation on the variable successful of engraftment. The data were processed with the package SISTAT 10®.

In addition, the same day were eradicated same young vine representing the sample analyzed for each treatment, in particular were taken 15 plants per treatment and divided into 5 samples of three plants each sample,the three plants representing the replicas; on these samples were measured diameter of the callus, diameter 5 cm below the graft and 5 cm above the graft, the aerial part was weighed and measured the distribution of roots in three classes: fine <2mm; medium> 2 <3mm; large> 3mm.

6.2 **Test A2: Study of the effects of the time of planting on yield in the field**

The final yield in the nursery depends not only on the histogenesis process of the grafts and thus yields and characteristics of the grafts-cutting after forcing, but also by the results obtained by the nurseryman in the fields. The test was conducted for only one year (2010) by comparing two eras of planting in the fields (1st planting: April 11, 2nd planting: May 15). The purpose of the test is to assess whether the factor studied influences the production of young vine. In particular, we have considered the combinations Grillo/140Ru using grafts-cuttings produced following the pattern of the forcing with sawdust previously described.

The data of this test was collected on 2010 but analysis of data was carried out this year Effect of time of plantation was evaluated after uprooting, were counted plants survived and making the successful percentage. Climatic data were evaluated during all the period spent in the field monitoring: Temperature, relative humidity, wind speed and direction.

6.3 **Test A3: Study of the effect of the color of callus on the yields in the fields**

The data for this test was collected for only one year (2010) and this year was conducted the analyze of data. The tests compared three colors of the callus (light, medium and dark) on two combinations of graft. In particular, we have considered the combinations Syrah/1103P and Muscat of Alexandria/775P, using grafts-cuttings produced according to the scheme of forcing with sawdust previously described. Was carried out a careful evaluation by the nurseryman of the grafts-cuttings for each of the two combinations (Syrah/1103P and Muscat of Alexandria/775P) and we proceeded to classify in relation to the color of the callus (Photo 21):

- grafts-cuttings with callus light color;
- grafts-cuttings with callus intermediate color;
- grafts-cuttings with callus-dark color.

For each thesis was produced a sample of 100 grafts-cuttings.

In the fields, for each treatment, were measured yields.

For each thesis, furthermore, were created 5 sub samples each consisting of 20 grafts-cuttings. For each sub-sample was determined the percentage of engraftment. Obtained the percentages for each treatment, we proceeded to the angular transformation of the data (Y = arcsin √P/100), where P is the percentage of sub sample. On the data thus obtained we proceeded to the analysis of variance to assess the significance of the sources of variation on the variable yield in the fields. The data were processed with the package SISTAT 10®. In order to make an objective evaluation on the color of the callus (selection, as mentioned, carried out by the nurseryman on the basis of visual observation), it is proceeded, on a sample of 100 grafts-cuttings for color class (light, medium and dark) and by combination of grafting (syrah/1103 P and Alexander Muscat/775P), to measure the chromaticity of callus by the colorimeter (Minolta CR 310). For each group were calculated by the standard deviation, mean and coefficient of variation of the three parameters L, a and b. (Table A1, A2). Where L indicates the clarity that goes from 0 to a theoretical black to 100 for perfect white, a and b indicate the chromaticity coordinates, and respectly follow the steps in color from red to green and from yellow to blue. The color data obtained were correlated with the color of the callus and calculated the regression equations. In the fields the conduction of grafts-cuttings, is the ordinary one used by businesses in the area, especially during the vegetative phase were carried calendar weekly treatments with fungicides. On 3 of August directly in the field were dected the number of grafts-cuttings engrafted for each thesis and calculated the yields on the fields by dividing the number of grafts-cuttings grafted divided by the total and multiplying by 100.

Also in this case for each thesis were created 5 sub samples each consisting of 1/5 of individuals or grafts-cuttings. For each sub-sample was determined the percentage of grafts-cuttings rooted. Obtained the percentages for each treatment, we proceeded to angular

Photo 21: Respectly callus light, medium and dark

transformation or in degree by arc sine of the given Y = arcsin $\sqrt{P/100}$ where p is the percentage of sub sample. Once processed the data was done by one-way analysis of variance for each source of variation on the variable yields in the fields. The data were processed with the package SISTAT 10®.

Tab. A1: Average, standard deviation and coefficient of variation of the indices of the chromaticity (L, a, b) detected by colorimeter (Minolta CR 310) on the callus of the combination of graft Syrah/1103P

Grouping callus clear			
Parameters	L	a	b
Standard Deviation	*6,1*	*6,3*	*4,5*
Average	*91,8*	*-1,4*	*3,1*
coefficient of variation	***7,0***	***464,0***	***146,0***
Grouping callus medium			
Parameters	L	a	b
Standard Deviation	*9,5*	*7,2*	*6,2*
Average	*88,5*	*9,0*	*-5,9*
coefficient of variation	***11,0***	***79,0***	***105,0***
Grouping callus dark			
Parameters	L	a	b
Standard Deviation	*8,8*	*4,9*	*6,1*
Average	*74,8*	*7,1*	*-1,1*
coefficient of variation	***12,0***	***70,0***	***579,0***

Tab. A2: Average, standard deviation and coefficient of variation of the indices of the chromaticity (L, a, b) detected by colorimeter (Minolta CR 310) on the callus of the combination of graft Alexander muscat/775P

Grouping callus clear			
Parameters	L	a	b
Standard Deviation	*10,2*	*6,8*	*7,1*
Average	*94,9*	*1,9*	*7,6*
coefficient of variation	***10,8***	***358,5***	***93,8***
Grouping callus medium			
Parameters	L	a	b
Standard Deviation	*8,7*	*7,8*	*7,0*
Average	*100,1*	*-1,7*	*8,8*
coefficient of variation	***8,7***	***459,1***	***80,1***
Grouping callus dark			
Parameters	L	a	b
Standard Deviation	*9,5*	*5,9*	*5,1*
Average	*81,5*	*4,2*	*13,2*
coefficient of variation	***11,7***	***139,0***	***38,8***

6.4 Test A4: Thermographic tests for the detection of graft-cuttings suitable for planting in the fields.

The experimental test performed consisted in carrying out the thermal-measures of grafts-cuttings that have just come out of the forcing chamber. The measurements were performed on three different lot of grafts-cuttings all from the "nursery Mannone" and collected in the period April-June 2014; the first lot consisted of grafts-cuttings that had just effected the second waxing and were of two different qualities, first and second qualities, based on experience of the nurseryman. The second lot consisted of grafts-cuttings just left the forcing chamber but had not yet undergone the second waxing and the third lot consisted of grafts-cuttings all of first quality.

The interest to develop a method to analyze the grafts based on the monitoring of the heat exchange is in the fact that, both the rootstock that the scions are constituted by a material well lignified and therefore compact; the callus which develops in proximity to the junction of the two bionti, due to the reaction of the plant to the graft, seen which is composed of young cells and the hardening phase or differentiation of tissues has not yet occurred, the consistency is softer, and with more porous structure. Therefore it is supposed that the behavior of such materials, in the transmission of heat, is different and that therefore it is possible to observe differences in behavior between the grafts-cuttings with callus developed than those with less developed callus. This would allow to formulate an index on the future success of engraftment in the field. To carry out this test, we used a frame to which they are individually suspended the grafts-cuttings; in front of the grafts-cuttings is positioned a screen for shield, when necessary, the grafts-cuttings from the heat source that consists of a halogen lamp from 1500 W. The measurement of the radiant flux emitted by graft-cutting is carried out thanks to a FLIR SC X6540 connected to a PC and a software, installed on the same PC, designed to manage the tool. The implementing shall consist in placing the grafts-cuttings on the support, properly oriented so as to direct the omega graft toward the camera(Photo 22). Then are to the heat source for a specified interval of time or until reaching a certain temperature, then the source is removed and expects that the grafts will arrive in balance again with ambient temperature. In front of the frame with the samples to be examined is placed the heat source at a distance such that the heat is issued in a uniform manner and without excessive gradients. The height of the source is adjusted so as to convey the light beam, for the most part, at the point of junction between the rootstock and scion. Just in front of the source, in the direction of heat flow, is positioned the mobile screen suitably covered, to intercept the beam coming from the heat source, during the cooling phase of the samples. The function of this element, is to avoid that the further radiation source can distort the data

Photo 22: Laboratory in order of acquisition of a thermographic test

acquired from the camera during the cooling phase.

The camera, which will serve to acquire the frames during the two stages of heating and subsequent cooling of the samples examined, is positioned opposite to the grafts at a distance such as to fit them all in the field of vision. Finally, through an ethernet cable, the instrument is connected to the PC which, thanks to the owner of the software Flir, allows the complete remotely management.

The acquisition of the thermographic data, for a total duration of three minutes, was performed for the first minute with the heat source in operation and for the next two minutes in the absence of the heat source, to monitor cooling (Photo 23). It soon becomes clear that the response time of the system are much slower, therefore the first test you can not appreciate any significant variation in the phenomenon of heat transfer, thus there is no difference between subjects. It is worth pointing that, the software allows you to set the sampling period

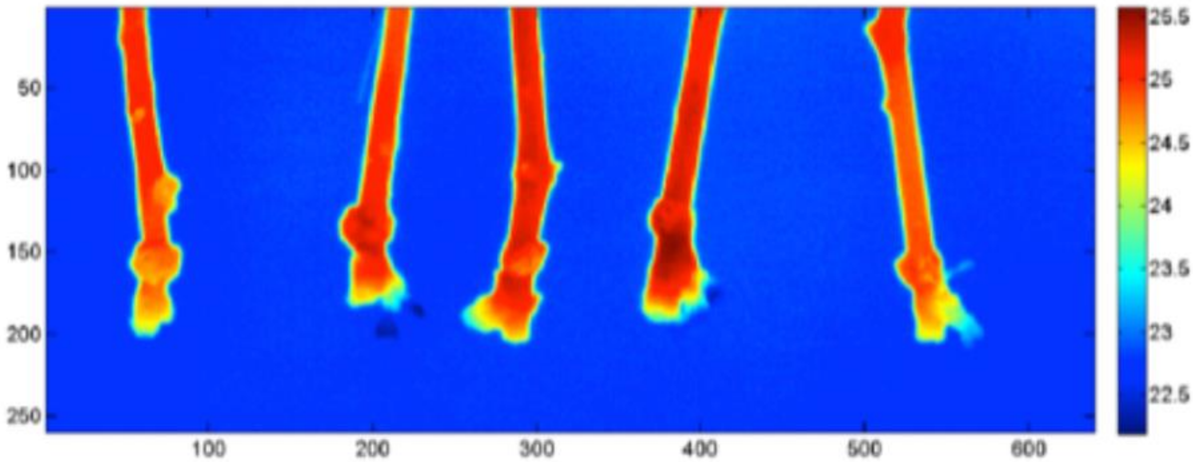

Photo 23: frame relative to an instant of the cooling phase

either automatically or manually (this will always be the preferred choice below). The second test is carried out, always on the same rack, by heating until the temperature of 30°C and continuing to monitor until the next return of the samples to ambient temperature; at this point the recording is stopped manually. The duration of this acquisition is about 20 minutes and from the frames appreciates the evolution of the phenomenon both in increment phase (shorter) that decrement phase (longer) of the temperature.

Within two months are tested about 120 grafts-cuttings, divided as anticipated, in three lots that are taken once a period of approximately 20 days. In all are carried out 16 tests in which, apart the first, are examined simultaneously with the camera 9 or 10 grafts-cuttings. In the first 10 trials are tested 9 graft-cuttings at a time, divided into 4 of second quality and 5 of first quality, in order to look for differences in the behavior heating / cooling between the two categories. In two of these tests assessing the differences between the grafts-cuttings with two waxing and those with only the first. In the last 5 measure are tested 10 subjects all of first choice because, want to focus the study by analyzing more in detail the state of maturity of the callus.

Of all tests are noted the peculiarities, such as for example a hole in the paraffin at the region of graft, a probably incorrect adjustment of the instrument, a development not uniform of callus, a movement of a subject during the test. These notes will prove invaluable during subsequent analysis of the results in order to justify the anomalous behavior with respect to the predictions made.

B)Test relating to the production of an alternative product to enter in the market (barbatellone).

6.5 Test B1: Production and formation of the "barbatellone" (1st year).

The study was conducted in 2011-2012 at a 'nursery company in the territory of Marsala (TP). During the first year of experimentation were produced in nursery grafts-cuttings to be transferred in in the field, acts to obtain the "barbatelloni." In the second year were evaluated vegetative and productive performances of "barbatelloni" in the open field. The trial evaluated five different distances on-row (6-12-18-24-36cm) in combination with two different combinations of graft in 2011 (Sauvignon Blanc and Alexander muscat) and three in 2012 (Moscato bianco, Cataratto Comune and Alexander muscat). All varieties were grafted using as rootstock 1103 Paulsen. All grafts-cuttings were prepared following the scheme of the forcing in water previously described. In the implant on the field were randomized the various types of grafts-cuttings, creating five blocks for thesis (variety and distance of implant), with 25 grafts-cuttings each block. During the growing season have set up a support; bud shoot occurred, we chose the shoot of which development corresponded to the extension of the young vine and was bound to support. During the vegetative phase were performed on irrigation, foliar fertilization, irrigation, trimming and fungicides treatment. The pruning of breeding has resulted in the removal of secondary shoot, allowing a greater increase in diameter of the main shoot (the future stem); later reached the predetermined length (about 1 m), was cut at the apex, in favor to accretion of the diameter of the principal shoot. For every thesis and on a sample of 10 plants per replication, have been detected already in the fields: vegetative growth in cm, number of nodes formed, shoot diameter in mm.

After the fall of the leaves, the extirpation was done manually, so as to maintain the integrity of the root system that has not been shortened as, instead, occurs in traditional production and the cuttings were arranged inside of the large wooden crates for their transport. Immediately after the extirpation were detected:

- Length of the root;
- Length of the stem;
- stem diameter at the second internode below the grafting point;
- diameter of the principal shoot at 70 cm from the point of engagement;
- the number of nodes in the principal shoot.

6.6 Test B2: Vegetative and productive characteristics of the "barbatellone" (2nd year)

In the second year of experimentation, only the "barbatelloni" of the variety Sauvignon blanc was planted in a field site in Petrosino (TP), where there was a vineyard in production; with the collaboration of 4 workers and with the use of a mini-excavator working on two rows in a single pass, was simultaneously eradicated 96 existing plants (that insisted on three rows) and implanted the “barbatelloni". The plants were subjected to regular surveys regarding their behavior vegetative-productive and has been studied the effect of the load of production on the growth of vegetation. At bud breaking, was evaluated the percentage of blind buds, the number of main shoots and secondary and their fertility. We proceeded then to make a cluster thinning of some plants and thus divide the trial in two theses: plants with production load and no-load production plants, randomizing all on 5 blocks per theses and 10 plants per block. From this time until the date of harvest, were measured weekly on all the plants, the length and the number of nodes of one apical shoot, one basal and one median. At harvest was weighed grape production for each plant (Kg) was calculated the average weight of the cluster by dividing the total output by the number of clusters. In winter has been weighing the wood removed in pruning and three plants of the two sample were eradicated to assess the development of the roots and comparing the two types of plants. To this end, it was measured the overall length of the roots divided into: fine (diameter less than 2 mm), medium (with diameter between 2 and 3 mm) and large (diameter greater than 3 mm). Finally it is calculated their percentage distribution on the total.

The data relating to vegetative parameters inherent in the development in the field were subjected to two-way analysis of variance, considering the variety and spacing of planting the main factors and the percentage of engraftment as the dependent variable. On the vegetative parameters was performed one-way analysis of variance, considering the distance of planting the independent variable. The data of field (2012) were subjected to analysis of variance to one-way, considering the type of plant (cluster thinning and not) the factor of variation. On the averages has carried out the test of TUKEY for alpha = 0.05. All statistical analyzes were performed with the package SYSTAT10®.

7 RESULTS AND DISCUSSION

A)Test relating to the management of the nursery and of the fields and effects on the characteristics of grafts-cutting products and yields in the fields.

7.1 Test A1: Study of two different techniques of forcing and two grafting techniques and effects on yield and quality of rooted cuttings.

This test had the aim to evaluate the effects of two different techniques of forcing (with water and sawdust), and two different grafting techniques (omega and interlocking multiple) on yields in the fields. The tests were carried out on a single combination of grafting (Cataratto / 1103P), deemed by the nurseryman commercial enough.

The analysis of variance (Table 1) show that the percentage of engraftment in the fields is not significantly dependent on the technique of forcing while, are significant, the type of graft and the interaction of the technique of forcing with type of graft.

Specifically, in figure 1 we can see that the forcing in water with both types of graft gave the same percentage of egraftment in the field (84%), while there were major differences in the box forced with sawdust, where the omega graft arrived to 91%, while multiple interlocking arrived only to 79%. The differences are attributable to a better response to omega graft that succeed to complete the repair quickly the vascular connections and therefore favors the grafting.

In figures 2 and 3 have been reported trends of temperature and relative humidity during the cycle of forcing of grafts-cuttings. It can be noted during the cycle of forcing has reached the maximum temperature of 36°C inside the forcing chamber but, within both the boxes has never exceeded the temperature of 31°C. The same can be said for the relative humidity inside the forcing chamber has fallen to 80% while, in the box with water mast is never below 95% and also achieved 100% and in the box with sawdust has never fallen below 90%. The data of temperature and humidity during the cycle of forcing can make us realize how important it is to maintain nearly constant over these two parameters that regulate the development of grafts-cuttings, and are directly involved in the development of possible attacks by pathogens to keep under control. The difficulty in the adjustment of these two parameters is due to the fact that the sensors generally measure the temperature inside the chamber that regulate the heating system, it is therefore necessary to know the relationship between temperature and humidity of the chamber and that of the boxes.

Tab 1: Effect of type of graft and forcing system on successful percentage in the open field (%)

Font of variation	% Engraftment
Type of graft (2)	*
Forcing system (2)	n.s
Tg x Fs (-)	*

*,** and n.s. indicate significance at α= 0.05, at α= 0.01, and not significant respectively

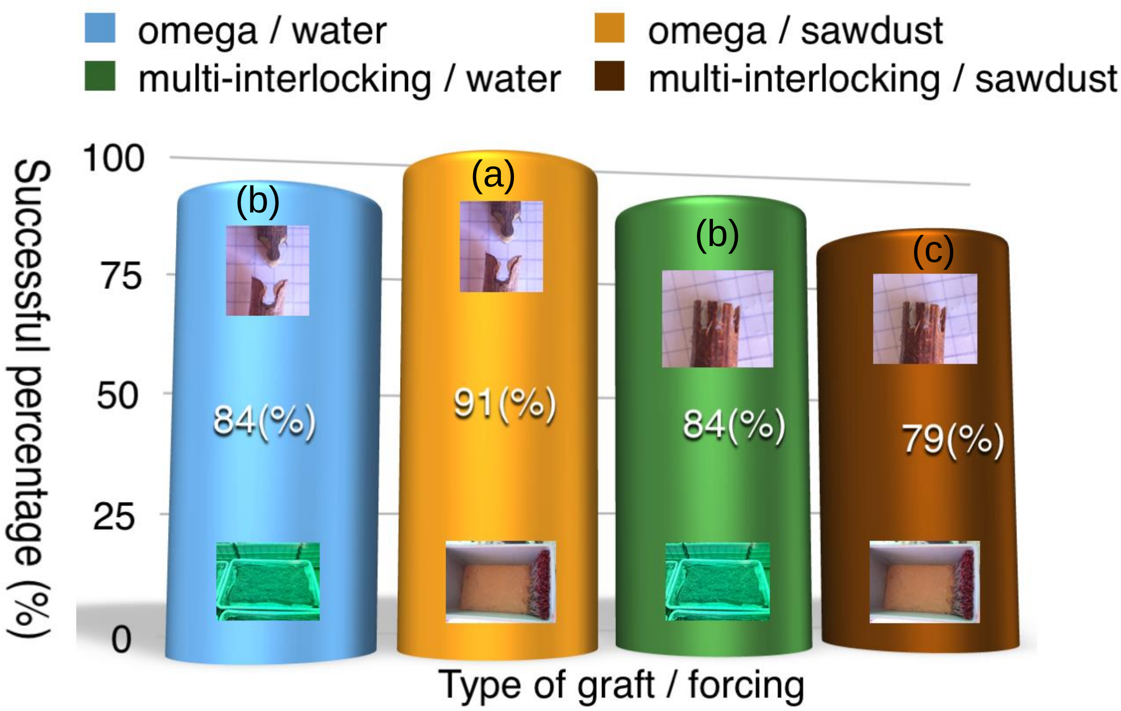

Figure 1: Effect of graft/forcing system on the successful percentage

* to different letters corresponds different statistically significative for value of α= 0.05

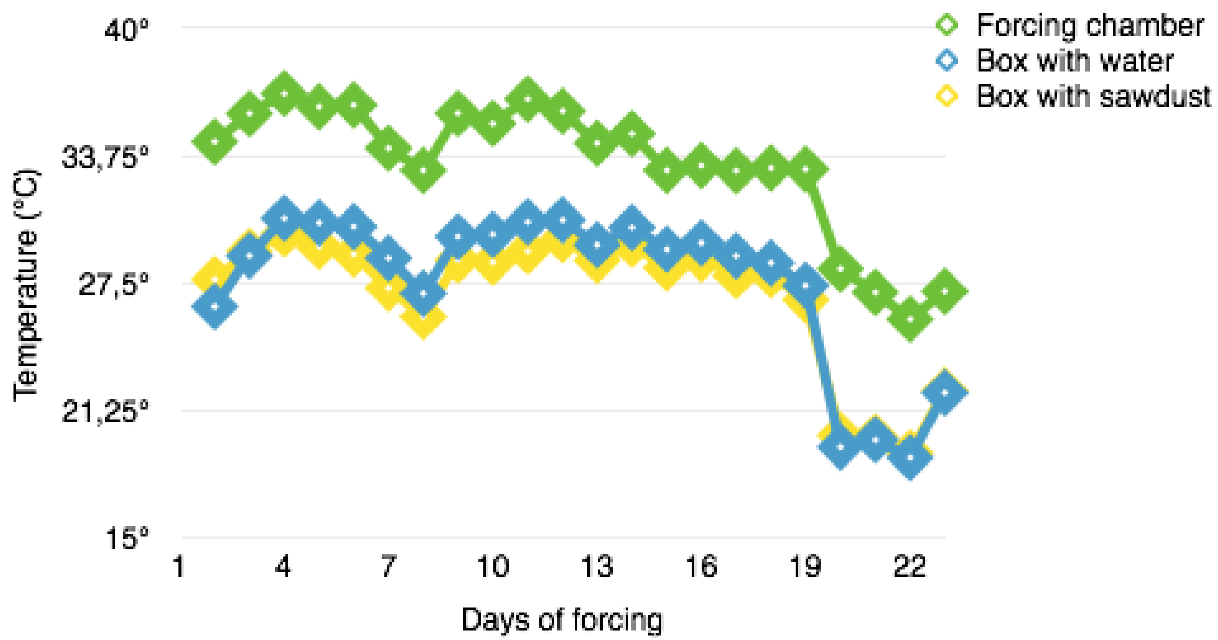

Fig. 2: Development of the temperature average daily of the two boxes (water and sawdust), and the temperature of the forcing room during the entire cycle of forcing

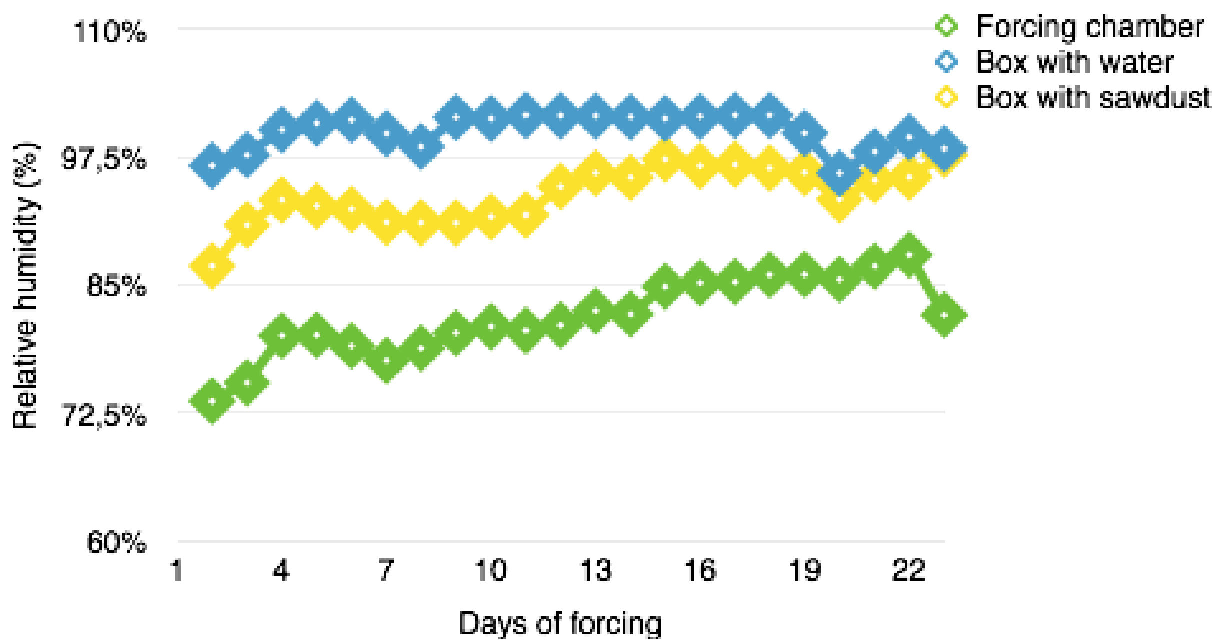

Fig. 3: Development of the Relative humidity average daily inside the two boxes (water and sawdust), and the Relative humidity of the forcing room during the entire cycle of forcing

7.2 Test A2: Study of the effects of the time of planting on yield in the field

For each period of planting data represent the mean of 4 values.

With regard to the study of the effect of the time of planting on the yields in the field, the results reveal that the studied factor influences the production of grafted. In fact, statistical analysis of the data at the time of planting, showed an effect with a significance level of $P \leq 0.01$.

Specifically, in Figure 4 we can observe that in the first period of planting (April 11) yields are equal to 93.33%, while in the 2nd period of planting (May 15) yields down to 75%, then, with a gap between the two eras of planting of 18.33%. These effects are probably attributable to the influence of climatic factors (temperature, relative humidity and wind), whose values are shown in Tables 2a and 2b.

In Table 2a, for the two dates of planting are shown: the summatory of the values of maximum and minimum temperature, the summatory of the relative humidity average of day and night, the wind direction and the summatory of the maximum and average speed of the wind ; related of the first 15 days after planting (from the 1st to the 15th day from the date of planting). In Table 2b, on the other hand, for each period of implantation, these values of temperature, humidity and wind speed were calculated by considering the second fifteen days after planting (from the 16th to 30th day from the date of planting).

From the data shown in Tab. 2a in the first 15 days after the first implantation period (11-25 of April), the summatory of the values of maximum and minimum daily temperature were respectively 303°C and 170.3°C, while the sum of the average values of relative humidity day and night were of 830.2% and 1310.75%, the average wind direction is, instead, of 210° (Libeccio), while its maximum speed was of 140 m/s and the average speed of 43.74 m/s.

Within 15 days after the second period of the plant (15 to 29 May), the summitry of the values of daily temperature maximum and minimum were respectively 392.5°C and 249.3°C, the relative humidity values day and night were of 630.5% and 949% of the wind direction was 170.3° (Scirocco), its maximum speed of 151.2 m/s and the average speed of 54.86 m/s.

From the data analyzed in Table 2a can be observed that:

- Differences (2nd epoch - 1th epoch) of the values of temperature maximum and minimum, and maximum and average wind speed during the first 15 days after planting at 2 epoch are positive, namely the differences was respectively 89.2°C, 79°C, 11.1 m/s, 11,12 m/s.
- The differences (2nd period - 1th epoch) of the values of relative humidity of the day and night, in the first 15 days after planting at 2nd epochs are negative, specifically the differences were, respectively - 199.7% and - 361.75%. The analyzed data thus show that,

in the first 15 days following the second period of planting temperature values are higher, the relative humidity is lower, while the wind speed is greater than in the first 15 days after the first epoch of planting. This shows how the values of high temperature, low relative humidity and high winds are responsible for the lower yields obtained in the second period of planting.

In the second fifteen days (Tab.2b) after 1th planting (from 26 April to 10 May), the summatory of the values of maximum temperature and minimum daily temperatures were respectively 342.1°C and 159°C, while the summatory of the average values of relative humidity at night and daytime are of 612% and 1222.5%, the average wind direction is, however, of 99° (Levante), while its maximum speed is 107 m/s and average speed 29.38 m/s.

The climate data relating to fifteen seconds days following the second period of planting (from 30 May to 13 June), the summatory of the values of daily temperature maximum and minimum respectively 380.2°C and 217.1°C, the values of relative humidity day and night were of 713.5% and 1280%, the average wind direction was 219° (Libeccio), its maximum speed of 99 m/s and the average speed of 23,36 m/s.

From the data analyzed in Table 2b can be observed that:

- The differences (2nd period - 1th period) of the values of maximum and minimum temperature, relative humidity day and night in the first 15 days after 2nd epoch of planting are positive, namely the deviation was respectively 38.1°C, 58.1°C, 101.5% and 57.5%.
- Differences (2nd epoch - 1th epoch) of the values for the maximum and average speed of the wind, in the first 15 days after planting at 2 epochs are negative, respectively -8.4 m/s and -6.02 m/s.

The data therefore show that, in the second fifteen days after 2nd epoch of planting, the values of temperature and relative humidity are higher, while, the wind speed is lower than the second fifteen days after the first period of planting. For which such data reveal that the effects of low yields in the field were mostly attributable to climatic factors that occur in the first 15 days at the time of planting that is elevated temperature and wind speed and low relative humidity.

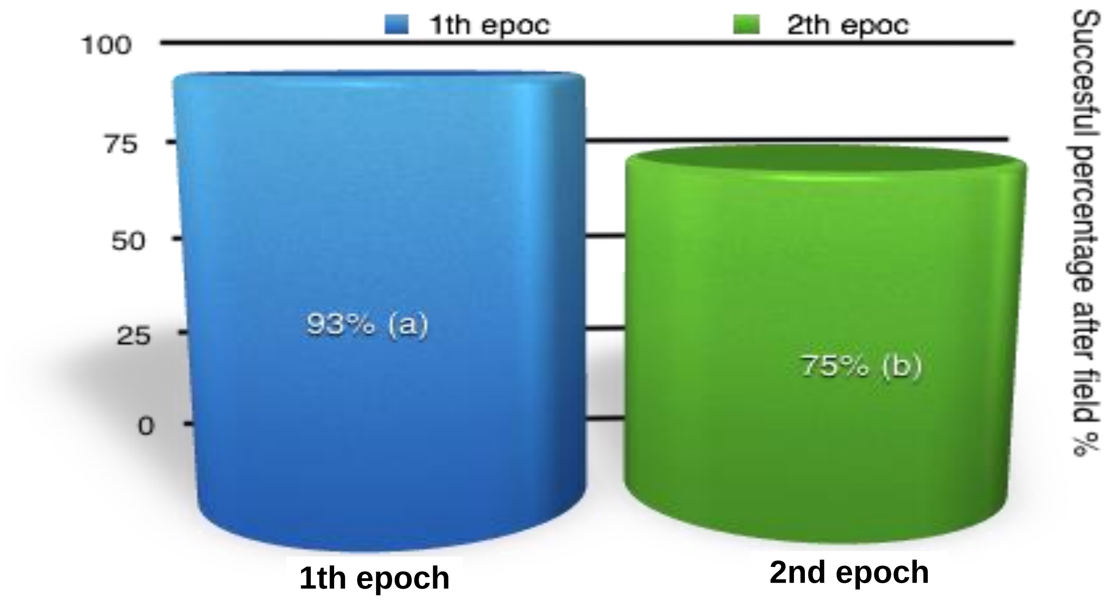

Fig. 4: Effect of different period of planting on the successful percentage.
*To different letters corresponds different statistically significative for values of P≤0,01

Tab. 2a: Summatory of climates values (from the 16th to 30th day from the date of planting)

Period of plant	Days after planting	Daily temperature (°C)		Relative humidity average (%)		Wind direction (°)	Wind speed daily (m/s)	
		Max	Min	day	night		Max	Min
1°	From 16th to 30th day	*342,1*	*159,0*	*612,0*	*1222,5*	*99,0*	*107,5*	*29,4*
2°	From 16 th to 30th day	*380,2*	*217,1*	*713,5*	*1280,0*	*219,0*	*99,1*	*23,4*
Values of difference between second and first period of plant		***38,1***	***58,1***	***101,5***	***57,5***	***120,0***	***-8,4***	***-6,0***

Tab. 2b: Summatory of climates values (from the 1th to 15th day from the date of planting)

Period of plant	Days after planting	Daily temperature (°C)		Relative humidity average (%)		Wind direction (°)	Wind speed daily (m/s)	
		Max	Min	day	night		Max	Min
1°	From 1th to 15th day	*303,3*	*170,3*	*830,2*	*1310,7*	*210,0*	*140,1*	*43,7*
2°	From 1th to 15th day	*392,5*	*249,3*	*630,5*	*949,0*	*170,3*	*151,2*	*54,9*
Values of difference between second and first period of plant		***89,2***	***79***	***-199,7***	***-361,7***	***-39,7***	***11,1***	***11,2***

7.3 Test A3: Study of the effect of the color of callus on the yields in the fields

This test was aimed to study the effect of the color of the callus, and the combination of graft, on yields in the field. We have chosen two combinations of graft among those available in the nursery: Syrah/1103 P and Muscat of Alexandria/775 P characterized by very different yields in the field respectively 94% and 58% (Figure 5).

From the results obtained it is clear that the color of the callus may explain the differences in performance in the field, particularly in combinations of graft characterized by low yields, while there is no influence on graft combinations which have given good results (Figures 6 and 7).

In the combination syrah/1103P the yield (%) on the field of grafts-cuttings was high for all three classes of color (clear, medium and dark); with respective values of 94% for grafts-cuttings with callus clear, 96% for grafts-cuttings with medium color callus and 92% for the callus with dark color (Figure 6).

For the combination Muscat of Alexandria/775P, as mentioned, the yield (%) of the grafts-cuttings in the field, showed significant differences in function of the coloring of the callus. In particular, it is observed how the grafts-cuttings with light color callus have provided lower yields of 46%, while the other two color classes, (callus medium and callus dark), showed the higher yields, in both cases 64% (Figure 7).

Despite have been found these differences to yield, according to the coloration of the callus, the analysis of variance showed no significant differences between the thesis ($P \leq 0.05$), while at the opposite ($P \leq 0.01$) for the combination grafting (Syrah/1103P and Muscat of Alexandria/775P).

From the results obtained through the colorimeter (Minolta CR 310), it is noted that the only parameter that can objectivising staining of the callus is the index L (Figures 8 - 9 and 10). Indeed correlating the values of L with the three types of callus determined visually high R^2 values are obtained in both two combinations of graft, Syrah/1103P and Muscat of Alexandria/775P, with values of 0.7297. This correlation is confirmed also for the single combination of grafting, for values of R^2 = 0.9253 for the combination Syrah/1103P and 0.9347 for the combination Muscat of Alexandria/775 P (Figure 8).

Using the index of chromaticity "a" does not evidence any relationship with the color of the callus, R^2 is 0.2674 for the total values, while for each combination of graft showed satisfactory values, for the combination Syrah/1103P R^2= 0.9048 while for the combination Muscat of Alexandria/775P R^2= 0.6953 (Figure 9).

The index "b" shows a high R^2 only for the combination Muscat of Alexandria/775P, while for both of the two combination graft does not highlight any relationship with the color of the callus (R^2= 0.4875), as well as for the combination of graft Syrah/1103P in which the regression coefficient R^2 = 0.0894 (Figure 10).

In conclusion, the use of chromaticity index "L" gives satisfactory results for the 2 combinations of graft tested, while "a" and "b" must deduce for each combination of graft valued.

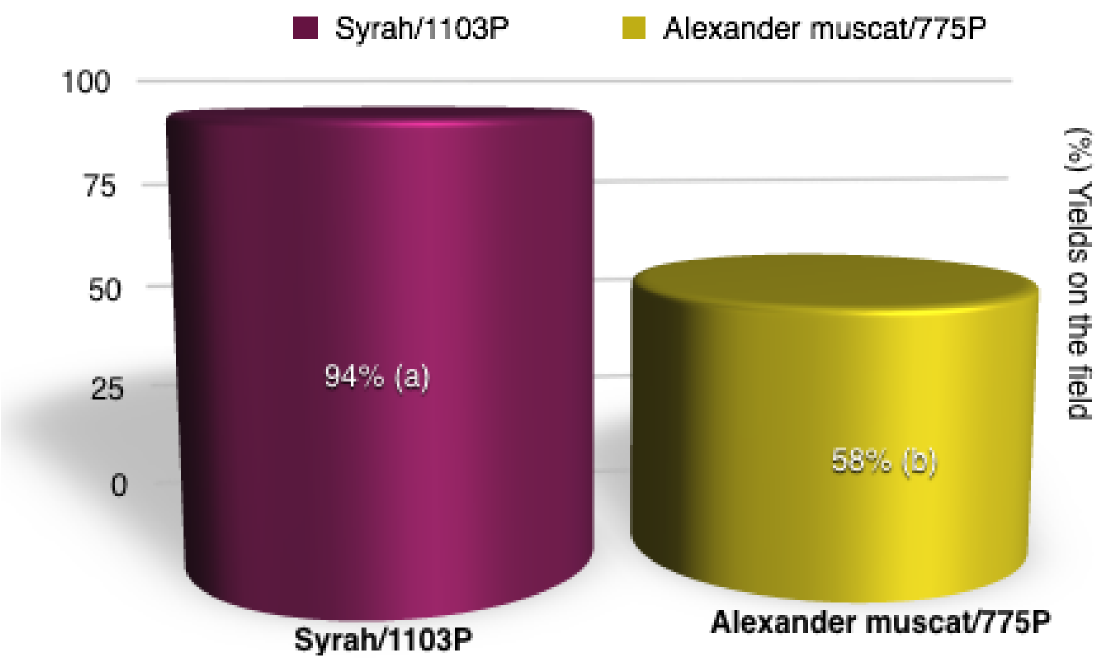

Fig. 5: Effect of graft combination on the fields.
*to different letters correspond different statistically significative for values of P≤ 0,01

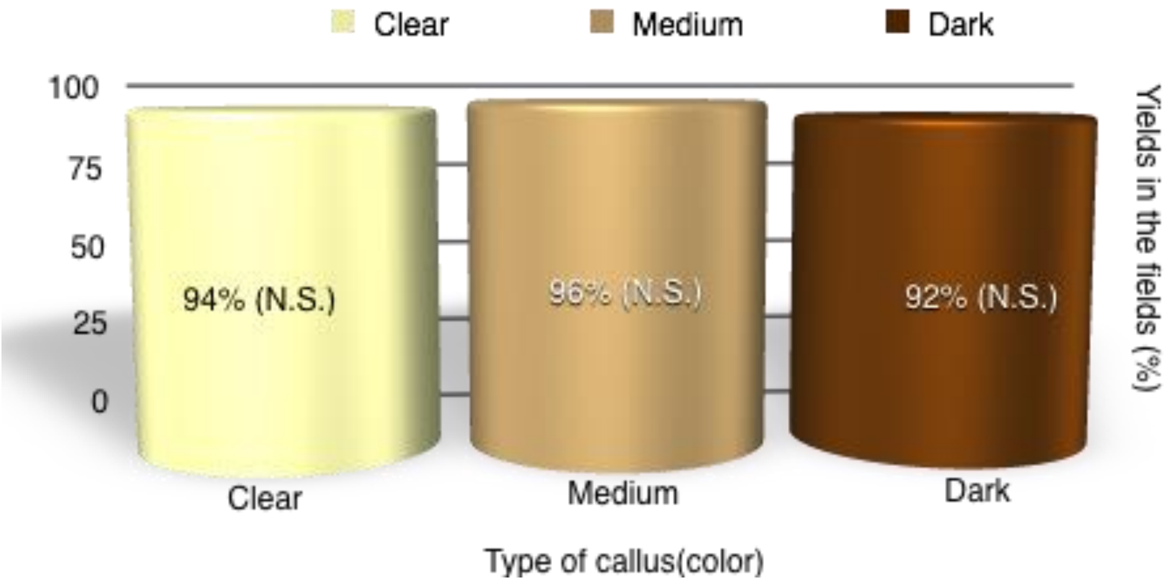

Fig. 6: Effect of color of the callus on the yield in the field (Syrah/1103P).

*N.S.= not significant for values of P≤0.005

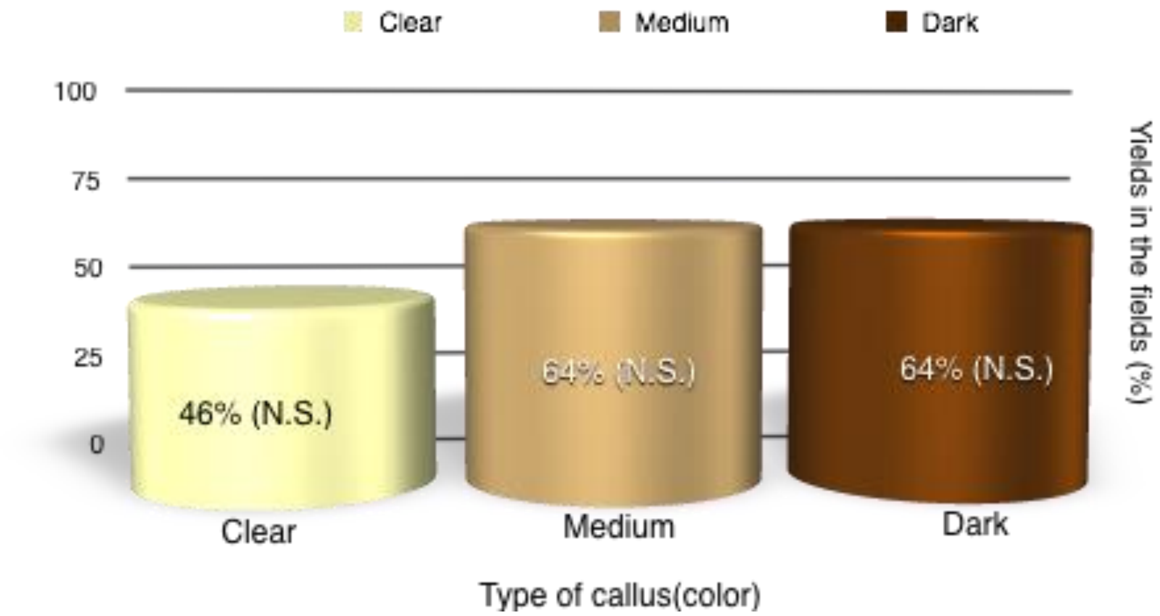

Fig. 7: Effect of color of the callus on the yield in the field (Muscat of Alexandria/775P).

*N.S.= not significant for values of P≤0.005

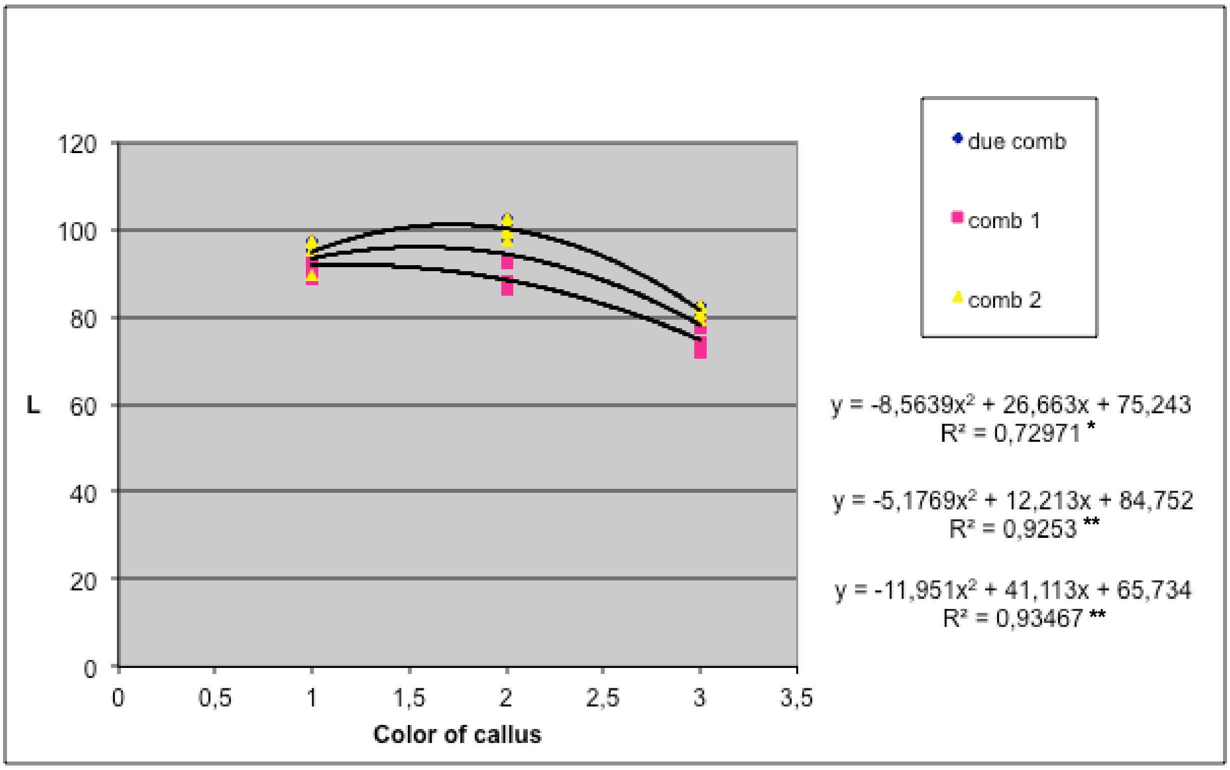

Figure 8: Relationship between the color of the callus and "L" in the 2 combinations of graft

*,** and n.s. indicate significance at α= 0.05, at α= 0.01, and not significant respectively

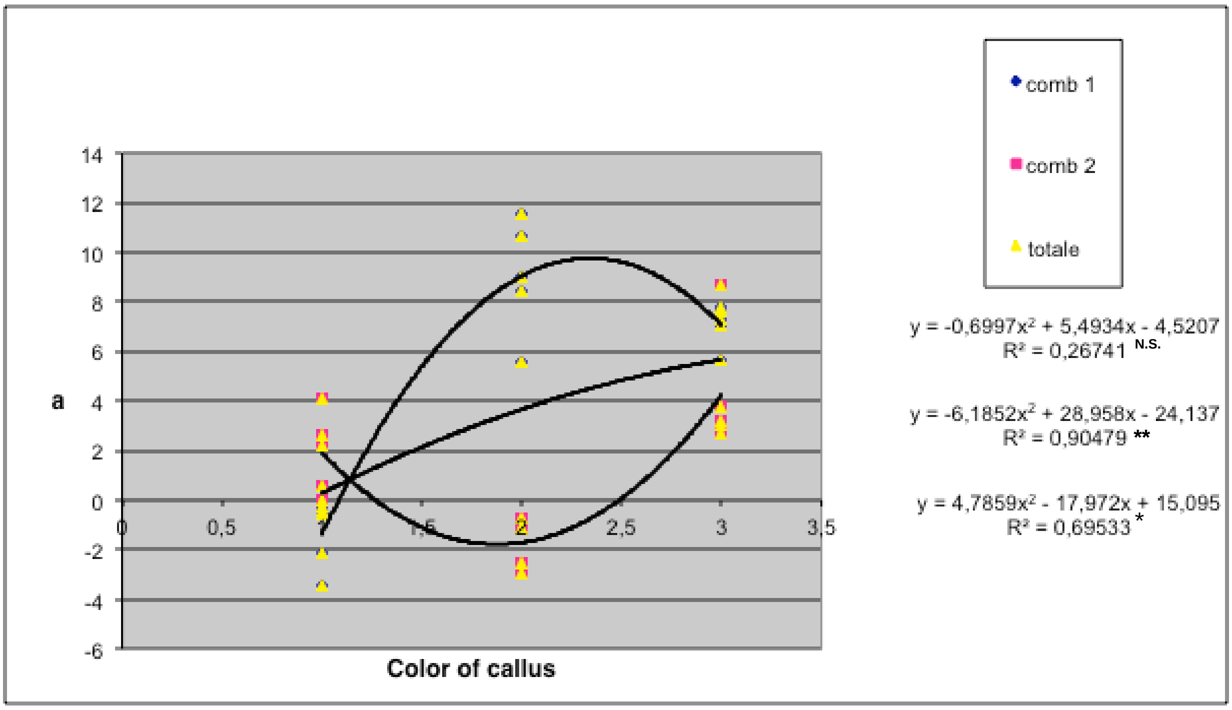

Figure 9: Relationship between the color of the callus and "a" in the 2 combinations of graft

*,** and n.s. indicate significance at α= 0.05, at α= 0.01, and not significant respectively

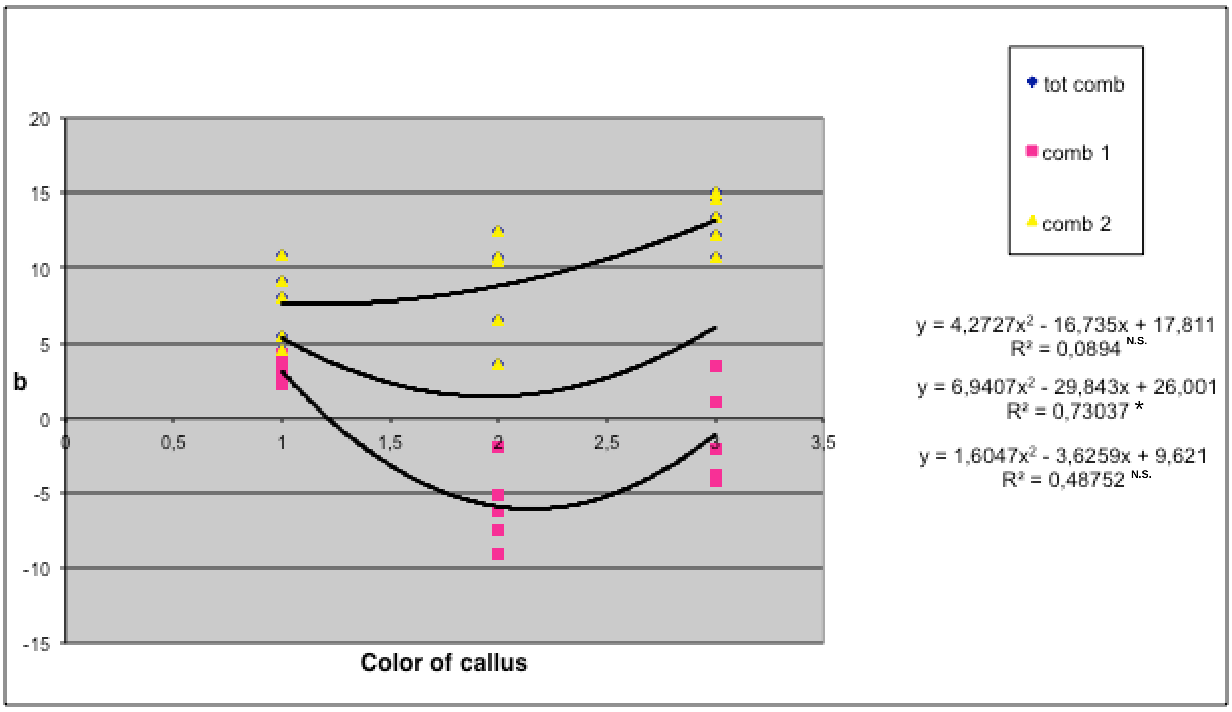

Figure 10: Relationship between the color of the callus and "b" in the 2 combinations of graft

*,** and n.s. indicate significance at α= 0.05, at α= 0.01, and not significant respectively

7.4 **Test A4: Thermographic tests for the detection of graft-cuttings suitable for planting in the fields.**

The techniques of investigation which has been discussed have led to observe differences in the measured parameters due, in principle, at the two categories of grafts available from the nursery (first quality and second quality). In particular, through the processing of the data acquired with the thermal test, we were able to obtain a comparison of the transient cooling of rootstock (upstream), graft (downstream) and callus (under study), noting essentially two types of behavior distinguishable from the time-temperature plots.

Among the grafts of first quality, those with a well-formed callus (hard) present the curves for the upstream, downstream and to the callus nearly coincident throughout the cooling phase (figure 11), indicative of the fact that the tissues forming the callus have reached a good level of maturity, then they are lignified giving rise to a homogeneous junction between the two bionti. By contrast between the grafts of second quality, those having a young callus (soft to the touch) present a uniform cooling as regards the upstream and downstream, while the curves representing the callus are detached from the previous indicating a lower temperature during all phase of release heat (Figure 12). This type of trend is associated with a callus material definitely different from that of the rootstock and the scion (the release of heat is dissimilar), in which the act of differentiation of tissues has not yet occurred and which is therefore not ready to resist to the other stages after forcing. For the latter, which from now on called grafts with *cold callus*, it is expected that the rooting is not going to succeed, and for the first, called grafts with *mature callus*, it is expected success. Furthermore it defines an intermediate behavior between the two previously described, in which there is evidence of separation between the cooling curves but this is not very clear (figure 13). The elements that have this trend are called grafts with callus semi-cold and not made any assumptions on the future engraftment; their interpretation is deferred until the analysis phase of the young vine in the field. For the categories of grafts with callus "cold" and "semi-cold" is calculated the average difference of temperature between the curves represented the cooling of the callus, and those relating to the upstream and downstream, so as to provide a useful parameter to characterize the aptitude to engraftment.

It is worth pointing out that, the grafts-cuttings of second quality in which the callus was not just developed, because obviously they did not have a reaction to the grafting procedure, the cooling is very similar to the grafts with "callus mature”. Indeed in the absence of callus, the area of graft appears to be composed of the same material of the upstream and downstream and therefore it has a uniform cooling. This, however, does not appear to be a disturbance for the purposes of our studies since the absence of the callus is visible with the eyes and, in such case, do not proceed to planting in the field. Additional considerations are made according to the layers of waxing present: both watching the succession of frames during acquisition that derived from the graphs we note that the grafts-cuttings R (only first waxing, red) have, during the period of increase, lower temperature levels, while the cooling is quicker. The first data is explained by the fact that the color of R is more opaque and spoiled (fig. 14a) because the paraffin it's more old compared to the subjects "green", whose waxing was performed instead few days before delivery of the lot. Therefore, the green ones being more glossy color therefore more reflective (fig. 14b), appear to the camera with a higher temperature, if irradiated by the light beam. Moreover, the second layer of wax just made and without imperfections is a perfect insulating casing which slows the evacuation of the heat, which is why the R have a faster cooling.

It is also evaluated the influence of any holes in the paraffin on the callus part, observing a phase of more rapid of heat release compared to areas with integrates wax, in fact, as can be noted from the image of Figure 14c relative to an instant of cooling, the area of the callus has a temperature much lower than the surrounding area. For these reasons, these grafts could

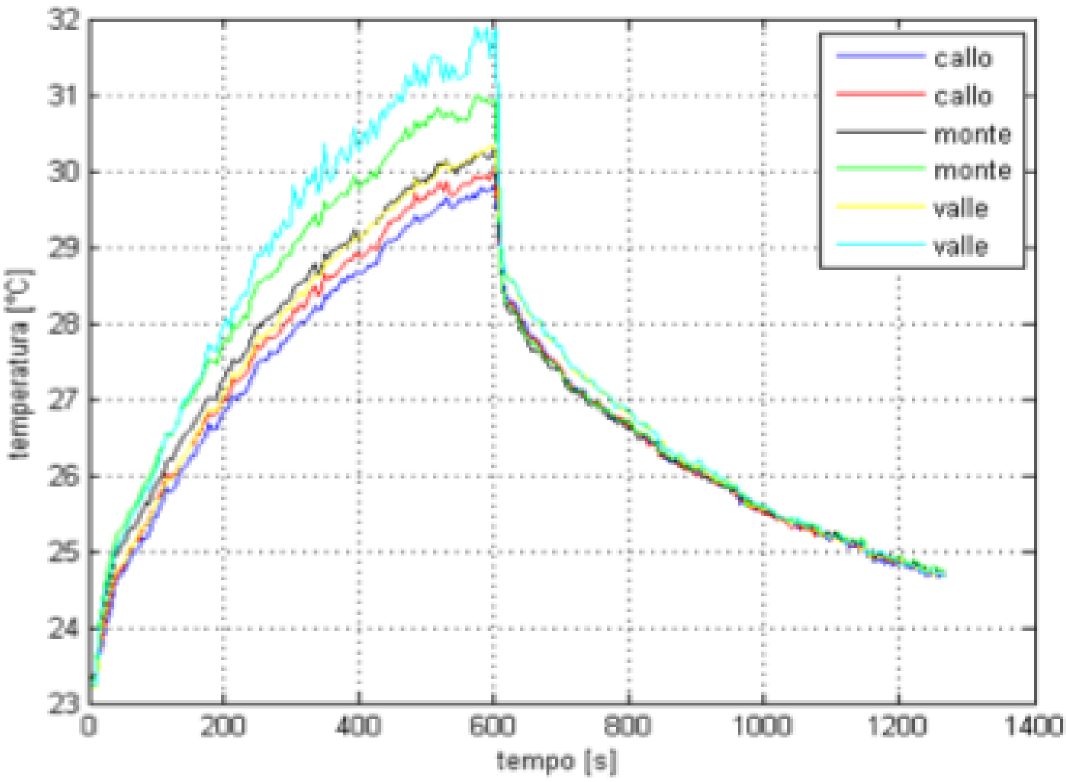

Fig. 11: chart temperature/time related to a graft with "mature callus."

be evaluated, perhaps erroneously, as graft-scuttings with callus fresh.

Of the 117 grafts-cuttings analyzed with the thermographic method, the 26 belonging to the class of calluses "semi-cold", or the uncertain, led to numerical evidence: if the average difference in temperature between the curves representing the cooling of the callus and those of upstream and downstream is maintained below 0.25°C there is a positive outcome of engraftment, if instead exceeds this value the result is negative. The table 3 shows a statistical summary of the results obtained with the thermographic testing, which also show forecasting errors committed for each class.

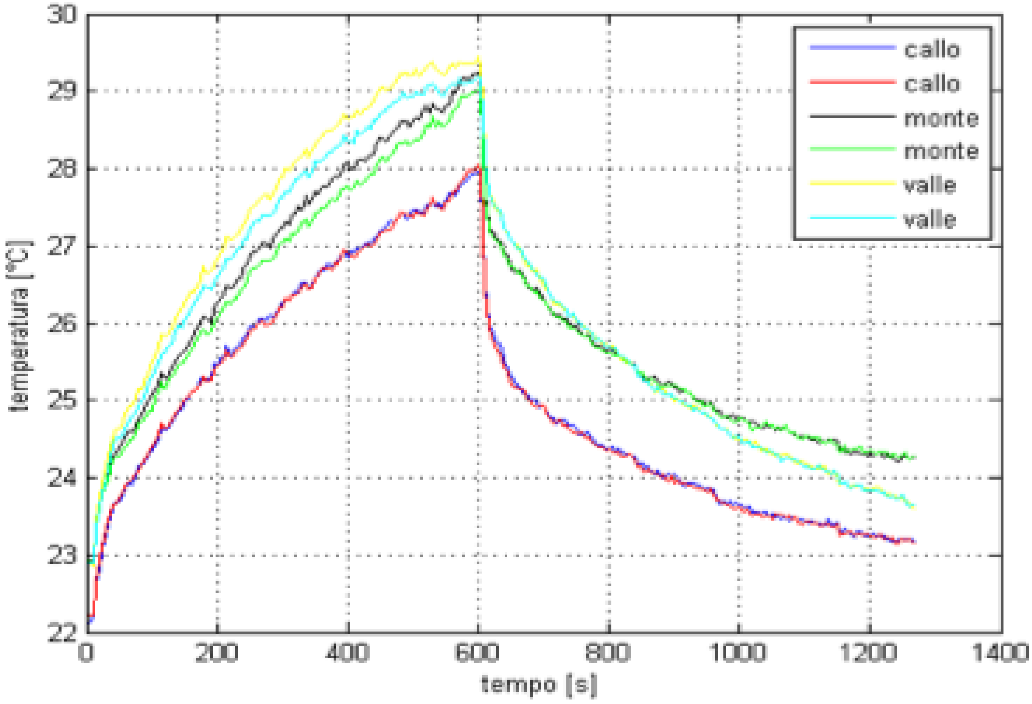

Fig. 12: graphic temperature/time related to a graft with "cold callus."

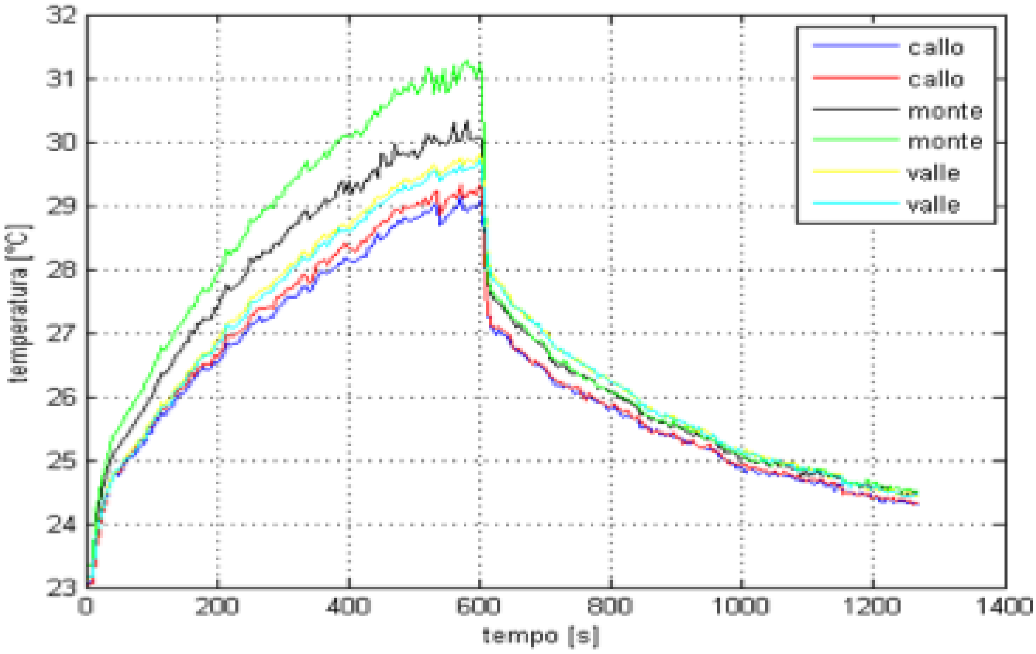

Fig. 13: trend accordant to the grafts with semi-fresh callus.

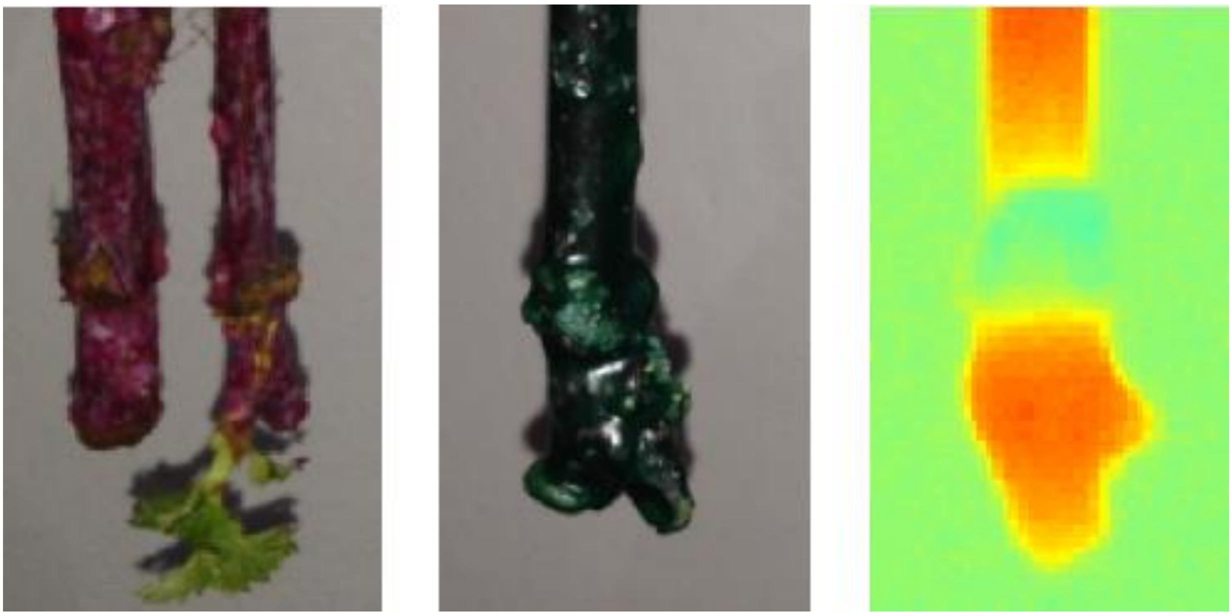

Figure 14 (a,b,c):a) graft with only 1st wax; b) graft with 2nd wax; c) graft with hole in the wax

Tab. 3: statistical table relating to the tests thermography.

category	cold	mature	semi-cold	total
Quantity	44	47	26	117
Forecast error (%)	25%	21%	n.a.	19%
Error related to the holes (%)	6,8%	n.a.	n.a.	2,9%

B)Test relating to the production of an alternative product to enter in the market (barbatellone).

7.5 Test B1: Production and formation of the "barbatellone" (1st year).

The analysis of variance (Table 4) show that the percentage of engraftment in the fields is significantly dependent on the variety while, are not significant, the planting distance and the interaction of variety with planting distance. In particular: between the two varieties studied in the first year, the one with the highest percentage of engraftment was White muscat. Also in the second year the White muscat confirms the highest percentage of engraftment along with Cataratto showing significantly higher values compared to the Muscat of Alexandria (respectively 84.4% and 90% versus 73%), (Table. 5).

The distance of planting in the field significantly affected the diameter of the stock and of the shoot while showed no significant effect on the length of the shoot, the number of nodes and the length of the roots. The vegetative growth of the shoot was put in relation to the 5 different planting distances, the obtained results are discussed in Table 6.

The diameter of the stock is found to be positively correlated with the distances of planting (fig.15), in particular by increasing the distances of the plant there is a linear increase of the said parameter with a R even higher, namely 98% (Fig .16).

The data obtained in the nursery show a clear increase of young vine vigour with increasing distance along the row, confirming what has been achieved by many researchers (Fregoni, 2005; Trapani, 2003; Pastena, 1990).

7.6 Test B2: Vegetative and productive characteristics of the "barbatellone" (2nd year).

The production load has altered the growth rate of shoot in fact, already after 7 days of plantation, the shoots thinned showed a higher daily grow than shoot with grapes. The growth rates were then standardized to 56 days from bud break when it had reached the potential of vegetative growth (Fig. 17).

As a result, already after 21 days of plantation, the shoots without grapes had greater lengths than the shoot with grapes. Then the differences have widened to 91 days after germination, when growth rates were almost uniform (Fig. 18). As reported in the literature (Intrigliolo and Castel, 2011; Pastena et al, 1990) the presence or absence of fruits modifies the activity of plant growth by increasing the vigor In fact, even in our case the absence of clusters significantly increased the values of the diameter of the stock and of the shoot, the shoot length and weight, the weight of the fruitful shoot, and then the pruned wood (Tab. 7 & 8).

The presence or absence of grapes on the vine did not, however, affect potential fertility in 2013 (the year after planting) was equal in both plants had produced in 2012 and in those who had no production. In both types of plants, however, there has been a significant reduction in potential fertility from 1.3 in 2012 to 0.54 in 2013. The plant probably has not been able to differentiate properly due to the balance between root system and vegetation, not producing adequate reserve substances. The vigor of the plants in fact, as evidenced by pruned wood, has not reached high levels and the plant has failed to fruit well the following year (Tab. 8). The fertility of the shoot is linked to its vigor (Fregoni, 2005; Bertamini, 2005; Trapani, 2003), in fact even in this trial has found a positive correlation between vigor and production. The most productive plants were those in the nursery had reached a greater vigor (Fig. 19) and that, in turn, were the plants that were located at a greater distance in the row. We can say, therefore, that the greater or lesser production of plants is already pre-determined in the nursery. The presence / absence of clusters has significantly changed the development of the root system of the plants. In particular, the plants thinned have produced a greater root mass (300 g against 131g), (Tab. 9).

It was possible to make a clear distinction between the root system belonging to the plants that had produced and that of plants without grapes. The roots of the plants that have produced grapes have a total mass and diameters smaller than those of the plants that have not produced, with the exception of the roots of the type "fine" (<3mm) that, to search for water and nutrients elements for the plant charge of grapes, have developed more. The vine without grapes have, instead, more developed root system, both as regards the diameters that the total mass; in both types of vine, it was found that the roots with a diameter between 3 and 6mm are predominant (45.3% versus 32.2% and 21.15% respectively for fine and big roots). In detail, the plant discharges have balanced the division between fine and big roots (respectively 25.6% and 24%), while the charges plants have produced more fine roots that big (respectively 38.9% and 18.3%). The ratio between aboveground and belowground plant part highlights how the plants were thinned balanced growth of the two parts (E / I = 1.1), while the plants uncropped developed a strongest aerial part (E / I = 1.7) due to the incidence of the grape, reducing root development, as previously mentioned (Tab. 9).

Table 4. Effect of variety and plant density on nursery successful (%)

Year	2011	2012
Font of variation	**% Engraftment**	
Variety (2-3)	**	*
Plant density (5)	n.s	n.s.
V x D	n.s.	n.s.

*,** and n.s. indicate significance at α= 0.05, at α= 0.01, and not significant respectively

Table 5. Mean of nursery successful on the two years

Year	2011		2012	
Variety		**± s.e.**		**±s.e.**
Sauvignon blanc	48.3 b	2.6	-	-
White Muscat	81.5 a	2.2	84.4 a	4.4
Catarratto Comune	-	-	90 a	2.8
Muscat of Alexandria	-	-	73.3 b	3.0

Means followed by a different small letters are significantly different at α= 0.05 (HSD Tukey's test). se=standard error.

Table 6. Effect of vine density on shoot characteristics

	Stock Ø	**Shoot Ø**	**Shoot length**	**Roots length**
	mm	*mm*	*cm*	*cm*
Plant density (5)	**	**	n.s.	n.s.

*,** and n.s. indicate significance at α= 0.05, at α= 0.01, and not significant respectively

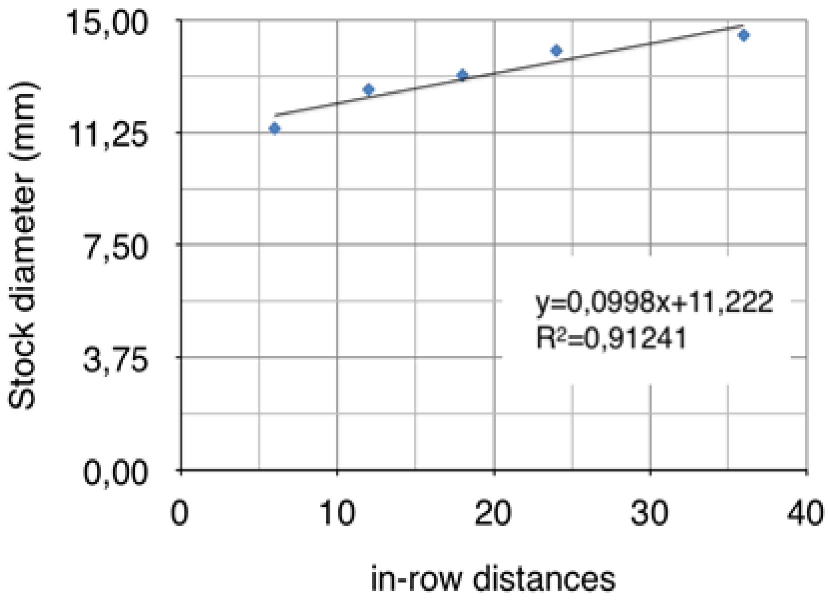

Fig. 15. Linear regression between stock diameter measured in the nursery and in-row distances

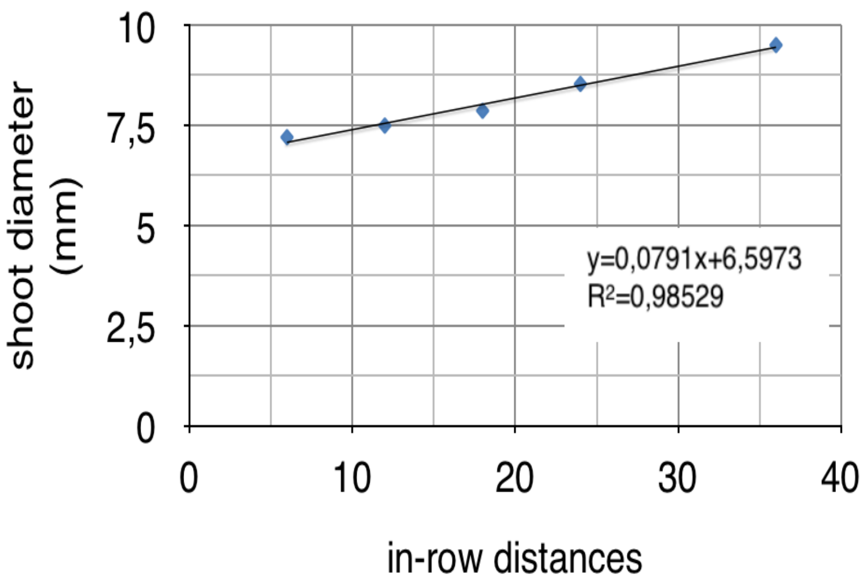

Fig. 16. Linear regression between shoot diameter measured in the nursery and in-row distances

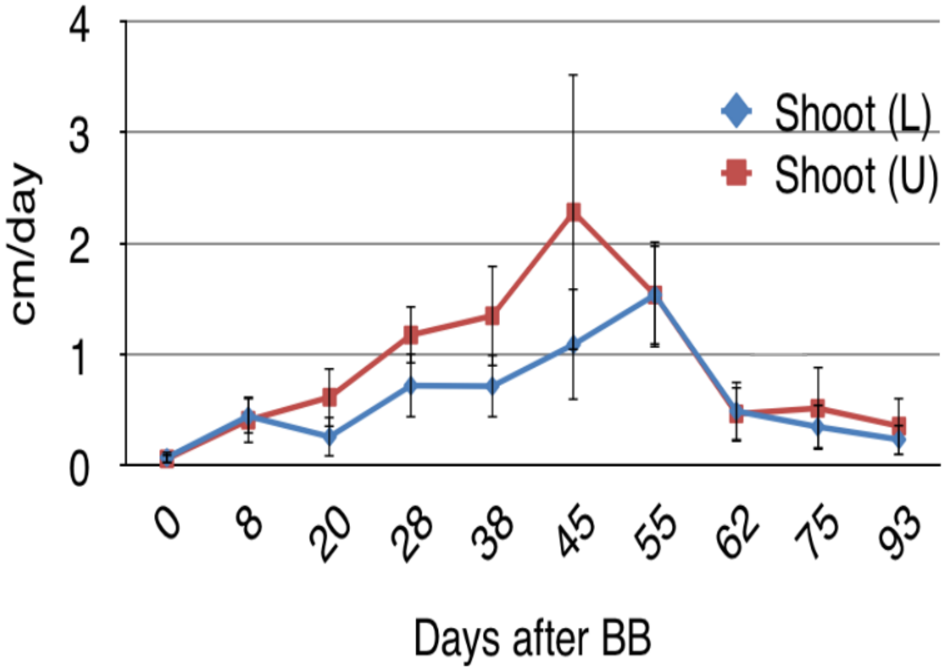

Fig.17. Daily rate growth of thinned (U) and not (L) shoots

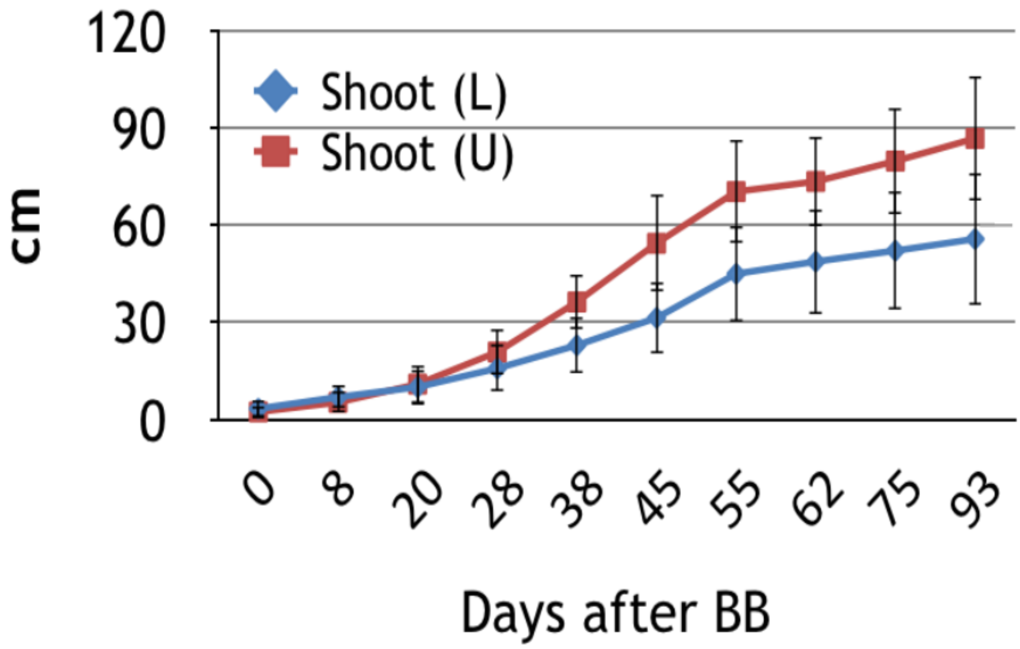

Fig. 18. Shoot growth of thinned (U) and not (L) shoots

Table 7. Effect of crop load on vegetative parameters

	Stem Diameter (under grafting point)	Stem FW	Stem Diameter (at 70 cm above grafting point)	Shoot lenght	Shoot FW	Root lenght profile	Cane FW
	cm	g	cm	cm	g	cm	g
Vine tipology							
Load	16.4 b	98.2 b	8.7 b	55.7 b	97.0 b	86 b	9.1 b
Unload	19.7 a	147 a	13.9 a	87.0 a	143.0 a	119 a	19.6 a

Means followed by a different small letter are significantly different at α= 0.05 (HSD Tukey's test).

Table 8. Effect of crop load on vegetative, quantitative parameters and bud fertility during 2 years

	Pruning mass	Yield	Bud fertility 2012	Bud Fertility 2013
	g	g	Bunch/shoot	Bunch/shoot
Vine tipology				
Load	99.5 b	578	1.3	0.54
Unload	180.8 a	-	1.3 n.s.	0.54 n.s.

Means followed by a different small letter are significantly different at α= 0.05 (HSD Tukey's test). n.s.=not significant.

Table 9. Effect of crop load on root characteristics (on total mass basis), total roots mass and aboveground : belowground ratio (E/I)

	Root distribution (%) (total mass basis)			**Total mass**	**E/I**
	< 3 mm	3-6 mm	> 6 mm	g	
Vine tipology					
Load	38.9 a	42.7 b	18.3 b	131 b	1.7 a
Unload	26.6 b	48.4 a	25.0 a	300 a	1.1 b

Means followed by a different small letter are significantly different at α= 0.05 (HSD Tukey's test). n.s.=not significant.

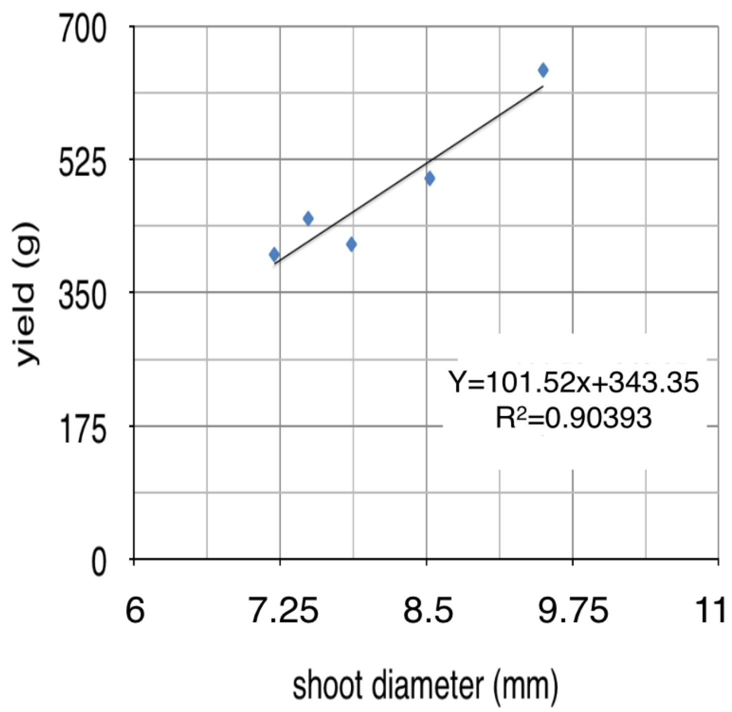

Fig. 19. Linear regression between yield and shoot diameter

8 CONCLUSIONS

The branch of the nursery is a very important sector for the development of viticulture.

Although the driving force (since the first vineyard to be formed should be implanted with propagation material) of the wine sector, very often, to the nursery, is not given proper attention and little is the bibliography about the problems of the constitution of young vine and about the yields in the field not always satisfactory (common denominator for most nurserymen, especially Sicilian). The results obtained have allowed us to make some considerations on the factors studied.

Taking into consideration the two types of forcing, these gave similar results but, given the simplification process that involves, forcing in water it is definitely preferable to one with sawdust, would also be to deepen the results in terms of quality of callus and product in general. Between the two types of graft is surely preferable the omega that in addition to giving the best results is also faster and more suitable for smaller calibers.

Considering the yields in the field it is seen that there is an effect linked at the time of plantation; later is the period of the plantation and is lower the yield in the field, then you must tend to implant in early periods in order to improve yields.

Understanding the responsible causes of the fluctuations in yields in the field and in forcing is not easy. There are many sources of variation and disturbance of this parameter. Objectify in more detail all the steps of preparation of the material upstream of the forcing chamber and in the subsequent stages, should be the future goal.

The characterization of the callus in a systematic manner by means of modern technology (Minolta colorimeter CR 310) gave results that must be investigated in consideration of the variability of the data according to the various combinations of graft.

From the results of engraftment detected at the nursery, it was found that the mistake made with the predictions of the thermal imager was 19%, which is satisfactory for an introductory study conducted on a small sample of about 120 grafts-cuttings through which it is developed an analytical methodology and results have been obtained. The study of individual factors that determine the yields both in the field that in forcing is of great importance for the nursery sector. In fact, small changes in rates of return, considering the high volume parts, affects not just the economy of the nursery. The results obtained lead us from one party to have some certainty about some determinants factors of production of young vine but, on the other, makes us aware that we need more further studies considering more combinations of graft and processes upstream of the constitution of the propagation material.

Taking into consideration the "barbatellone," this product was created with the objective of proposing to vine-growers an innovative propagation material that reduces the variability of the vineyard (with the replacement of the failed areas), facilitating the management of the vineyard during breeding, anticipate the first production by reducing the non-productivity phase of the vineyard, planting maintaining all the supporting structures of any existing vineyard and saving on installation costs. Plans for the near future will be to continue with this project to deepen even more the results obtained; in particular test other combinations of grafting and different environmental conditions.

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