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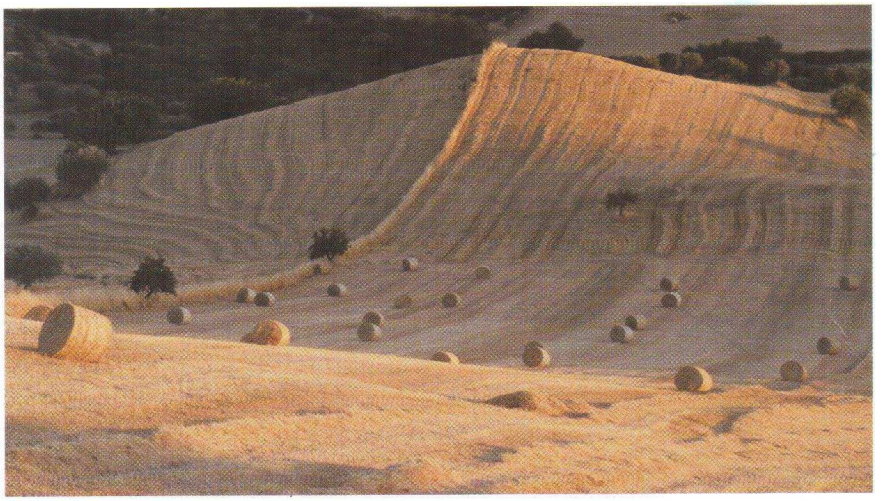
# ***Book of Abstracts***



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# Transplanter with Laser System for Vineyard and Superintensive Olive Plant

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**Abstract**
**In the last ten years we have been assisting to an increasing diffusion of the automatic transplanting machines in the vineyard plant, that allows to plant the vine cuttings with a large root apparatus, which is fundamental in order to obtain a rapid and correct plant growth. The technological evolution of these machines led to fine tuning of laser alignments system to transplant the vine seedlings. This system has been improved thanks to the use of the satellitic receiver, of most recent introduction, which determines the number of necessary poles and vine cuttings, right after having located the borders of the surface.**
**The aim of this work was to evaluate the technical and operative characteristics of the automatic transplanting machine Wagner, equipped by a laser system, working in two different Puglia localities, characterized by the same climate conditions, but different in the matter of the ground kind. The work quality of the transplanting machine on the strength of taking root percentage of the planted material have been evaluated.**
**The trials pointed out that the machine efficiency depends, especially, on the structural typology of the ground as well as on the surfaces position, with operative times and intervention costs always very low in respect to those supported with the manual plant.**

**Keywords**: transplanting machine, vine cuttings, vineyard

## Introduction

The vineyard plant is a very old practice, executed manually until the eighties. The techniques adopted for the transplant foresee the vine cuts placement into pits or trenches dug along the line row. The new mechanized plant systems uses the transplanting machines, which determines aesthetic and functional improvements of plants, being more easy to work, obtaining a low incidence of dead times. The necessity to reduce the cost of the vine plant and the possibility provided from the evolution of the operative machines, increase the interest about the mechanization of the vine cuttings plant (Carrara M. et al., 2001, Planeta et al., 2001).
In the last years the vineyard changed gradually with regard to the planning phase, that it has been simplified by the introduction of topographic tools allowing to quit the old measure systems, obtaining optimum results due to the precision of the tracing and staking field phases, that in the past implied time and much work.
The laser alignment system has been extended to the plant phase subsequently too, allowing to drive the transplanter, constantly keeping on-axis with the files. A greater production quality it obtains, with a considerable reduction of the costs and time work. We reached to

this mechanic innovation later on recruitment difficulties and high costs labour, given that the considerable manually work required by vineyard.
The laser transplanter use increases the vine cuttings number planted per day in respect of the manual transplant, assuring the seedlings alignment along the file at the same time. Furthermore there is the possibility to leave a consistent root apparatus, favouring a rapid growth and a precocious production.
Some researches of the last years carried out that the vine cuttings planted mechanically have a growth 2-4 time greater than seedlings planted manually (Pipitone F., 2006), because with the transplanter the hearth adheres mainly to the roots without to create empty spaces and there is a greater resistance to water stress, thanks to use of vine cutting with a long root.
The aim of this work was to analyze the work quality of a transplanting machine with laser system, for the vineyard plant in three sites, on the base of the results deriving from the trials field. It has been possible to evaluate the incidence of the soil characteristics, typical of site, on the performances machine.

## Materials and methods

The analysis, concerning the modalities of the vineyard plant realized by a mechanic laser transplanter, regarded three Puglia zones: Sammichele di Bari, Acquaviva delle Fonti and Putignano. The grounds are extremely different while its climatic characteristics are similar for those localities where the machine worked.
The vine cuttings used in the mechanized plant belong to *Vitis vinifera* species, cv. *Primitivo*, of two years and 0,60 m. Before to the experimental trials an adequate ground preparation has been executed, consisting of a leveling out allowing to the machine to work in a fluid way and the processing to make it untied, assuring an optimum adhesion to the root apparatus.
In the laser tracing the seedlings collocation has been made in a single direction and at the end of file needed to return to the initial headland. The tractor places itself in a new file to plant and it is necessary to put into effect the distance control system between the vines on the row.
This distance is controlled by hydraulic and mechanic system, based on the unrolling of a stainless steel wire, rolled on a reel placed in the overboard machine and previously fixed to its extremity, on a picket driven in the beginning of the file.
The machine used is the Wagner transplanter model Champion, mounted by a tired tractor 73 kW, characterized by a frame with one or two seats for the operators, which prearranges the seedlings on the machine members to position them on the ground. This machine has a rotative distribution mechanism, where the radially pliers brings and releases the vine cuttings (figure 2). The pliers open itself to receive the seedling placed by a worker in the edge machine and opens itself in correspondence to the bottom furrow, putting the seedlings vertically. The furrow has opened previously by a plowshare that works with a variable depth according to the soil and it has closed by two converging wheels, making compact the ground on the root apparatus.


**Figure 1. Wagner transplanter.**

**Figure 2. Pliers for the seedlings taking.**

The transplanter machine has equipped by a laser system, based on an aboard receiver (figure 3) and by a sender in correspondence of the file to plant (figure 4), allowing a correct alignment of the transplant device on the row, with an error contained in 3 cm.

**Figure 3. Riceiver on the transplanter.**

**Figure 4. Sender on the file.**

The yard was composed by a worker on the helm of the tractor, one or two operators on the edge machine for the seedlings plant, one in the head plat for the laser device displacement and finally a worker for the vine cuttings preparation.
The transplanter is able to plant at a minimum distance between the rows equal to 1.20 m and on the row equal to 0,70 m; in this case the following values was been established.

**Table 1. The calibration values of the Wagner transplanter.**

| Distance among the rows (m) | Distance on the row (m) | Depth (m) |
|---|---|---|
| 2,40 | 1,20 | 0,40 |

For each plant we proceeded to measure the distance among the rows, the distance on the row and the depth of the vine cutting plant, effecting 50 measurements in each site and for all parameters considered. Specifically the depth value has been obtained from the difference between the total length of the seedling, comprising the root apparatus, and the length of the epigeous portion, after the plant. Finally the data deriving from the field trials have been submitted to the variance analysis with one factor, using the analysis tool of Microsoft Excel

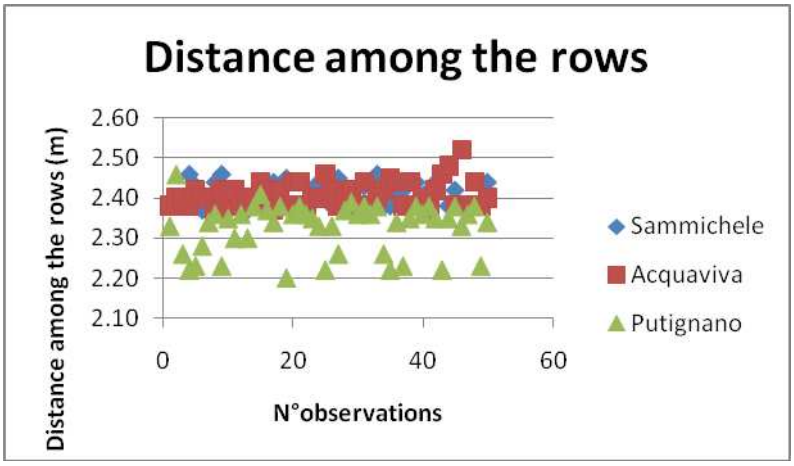
2007. In this manner we analyzed the difference between the arithmetic means of the groups, correspondent to the different localities in respect to three parameters considered and we verified these statistical hypothesis:

- $H_0$: $\mu_1 = \mu_2 = \mu_3 = \ldots = \mu_t$
- $H_1$: $\mu_i \neq \mu_j$ for some **i** and **j**

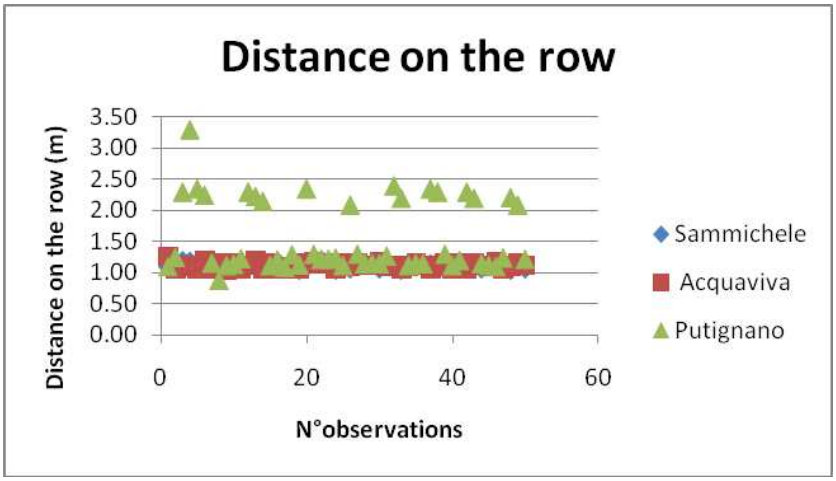
According to the null hypothesis the means are equal between them; in the alternative hypothesis at least two means are significantly different.

**Results**

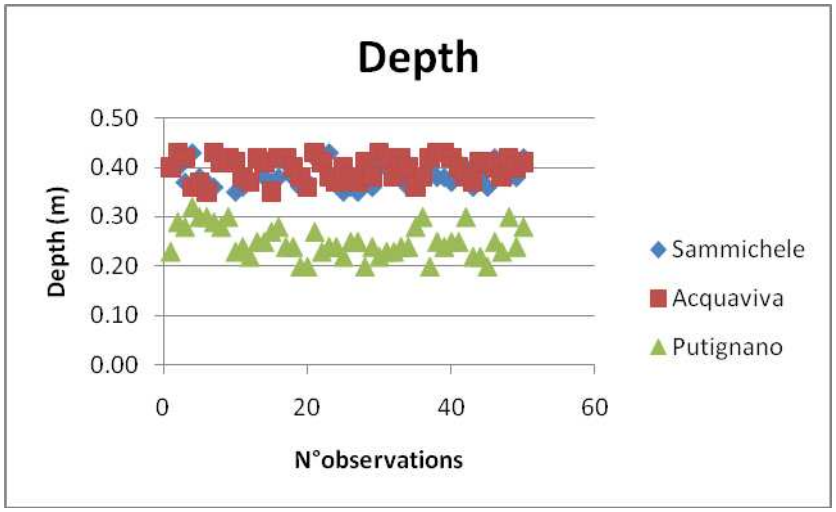
The field trials provide results quite similar for the Sammichele di Bari and Acquaviva delle fonti sites, totally different for Putignano site. In the first two localities the ground has been submitted to a preliminary settling, in order to assure a good nimbleness, avoiding difficulties during the transplanter work.
The following dispersion graphs (graphs 1,2,3) report the values of the three parameters analyzed and shown as the data relative to the first two localities lay upon them often, indicating that the characteristics of these sites are extremely similar, unlike the Putignano plant characterized by values very different in respect to the calibration values of the machine.
In this plant the transplanter worked in a difficult ground, very stony, that needed several preliminary operations, such as the break and the smashing of the rocky layer in order to transform them in a cultivable land; these operations have not been effected.
An untied, dry and without stone ground is the optimal condition in order to receive the vine cuttings and to assure an easy work from the transplanting machine. The Putignano site does not shows any of these characteristics.




**Graph 1. Distance among the rows.**




**Graph 2. Distance on the row.**




**Graph 3. Depth**.

The experimentation conducted using the variance analysis with one factor had the aim to evaluate the work executed by the mechanic transplanter, examining the data acquired in the field and comparing them with the initial machine values.
These are the results deriving from the variance analysis for each parameter, in the localities examined.

***DISTANCE AMONG THE ROWS***
RECAPITULATE

| Groups | Count | Sum | Mean | Variance |
|---|---|---|---|---|
| Sammichele | 50 | 120,38 | 2,407 | 0,000985959 |
| Acquaviva | 50 | 120,43 | 2,408 | 0,001036776 |
| Putignano | 50 | 116,39 | 2,327 | 0,003801184 |

VARIANCE ANALISYS

| **Variation source** | **SQ** | **gdl** | **MQ** | **F** | **P-value** | **F crit** |
|---|---|---|---|---|---|---|
| Among groups | 0,214961333 | 2 | 0,107480667 | 55,36513 | 1,19445E-18 | 3,05762 |
| In groups | 0,285372 | 147 | 0,001941306 | | | |
| Total | 0,500333333 | 149 | | | | |

***DISTANCE ON THE ROW***
RECAPITULATE

| **Groups** | **Count** | **Sum** | **Mean** | **Variance** |
|---|---|---|---|---|
| Sammichele | 50 | 55,9 | 1,118 | 0,001808163 |
| Acquaviva | 50 | 55,9 | 1,119 | 0,001866327 |
| Putignano | 50 | 78,0 | 1,561 | 0,327323918 |

VARIANCE ANALISYS

| **Variation source** | **SQ** | **gdl** | **MQ** | **F** | **P-value** | **F crit** |
|---|---|---|---|---|---|---|
| Among groups | 6,54461 | 2 | 3,272306 | 29,65850 | 1,51182E-11 | 3,05762 |
| In groups | 16,21892 | 147 | 0,110332803 | | | |
| Total | 22,76353 | 149 | | | | |

***DEPTH***
RECAPITULATE

| **Groups** | **Count** | **Sum** | **Mean** | **Variance** |
|---|---|---|---|---|
| Sammichele | 50 | 19,27 | 0,3854 | 0,000564122 |
| Acquaviva | 50 | 19,91 | 0,3982 | 0,000570163 |
| Putignano | 50 | 12,52 | 0,2504 | 0,000995755 |

VARIANCE ANALISYS

| **Variation source** | **SQ** | **gdl** | **MQ** | **F** | **P-Value** | **F crit** |
|---|---|---|---|---|---|---|
| Among groups | 0,67056 | 2 | 0,335280667 | 472,21724 | 1,01157E-64 | 3,05762 |
| In groups | 0,10437 | 147 | 0,000710014 | | | |
| Total | 0,77493 | 149 | | | | |

From the variance analysis results as the F value calculated is greater to F critic for all variables analyzed and that bears out the alternative hypothesis whereby the means are significantly different among them. Specifically for the Sammichele and Acquaviva sites the mean of the data analyzed is very near to the predetermined value and the variance is very low, that means the data are quite homogeneous. We can infer that the vine cuttings have been planted respecting the calibration values of the transplanter for all parameter.
For the Putignano site the variance values have been greater, because the initial data were heterogeneous and distant from the calibration values; in this case the work executed by the transplanter was totally negative. In fact the machine does not guaranteed the alignment precision and an adequate depth. The lack of the ground settlement and its intrinsic characteristics are the causes of the low quality work obtained in the last plant. To this purpose in this site some ground samples have been taken and the analysis have been effected by the chemical laboratory of our university *(*table 2*).*

**Table 2. Analysis of the ground of the Putignano site (Source: Laboratory of Chimical Department of the University of Basilicata).**

| | |
|---|---|
| Ground humidity | 9 % |
| pH | 7,45 % |
| Electric conductivity | 3,91 |
| Coarse sand | 5,7 % |
| Fine sand | 11,4 % |
| Clay | 29,2 % |
| Coarse slime | 17 % |
| Fine slime | 36,7 % |

From this table we note as the ground analyzed is loam-clayey and with a low percentage of sand, fundamental to assure a good drainage. The high quantity of stones makes this site further difficult to work.
The following table reports the results relative to the different performance transplanter in the three sites and the rooting percentage that constitutes the principal indicator of the outcome work.

**Table 3. Data work of the Wagner transplanter.**

| Sites | Advancement speed (Km/h) | Operative capacity (plants/h) | Real capacity (plants/h) | Rooting (%) |
|---|---|---|---|---|
| Sammichele | 2,5 | 950 | 650 | 95 |
| Acquaviva | 2,5 | 950 | 600 | 90 |
| Putignano | 1,5 | 470 | 270 | 75 |

The transpalnter in the Putignano site had difficulties in the advancement, due to the lack of the leveling and to the presence of stones on the ground. That allowed to reach a work

capacity more low in respect to other two sites equal to about 60%. The ground characteristics influenced the rooting seedlings, satisfactory in the Sammichele site, equal to 95% and limited in the last site considered, equal to 75%.

## Conclusions

The research conducted pointed out that the use of the transplanting machine is fundamental to increase the productivity work, to contain the labour needs and to reduce the costs for the vine cuttings plant. The advantages deriving from the high operative capacity working in optimal conditions and from the high rooting percentage, higher to 90%, are undeniable.
If on one hand the purchase money of a transplanter is high for small and middle firms, on the other hand the outsourcers are able to propose the mechanic transplant with advantageous prices. At present the principal problem is the reduced employ of labour and the transplanter use is an alternative to the difficult of its recruitment.
This analysis pointed out that is necessary an adequate preparation of the ground in order to a correct working machine and to assure an optimum adhesion of the ground to the root apparatus; besides the seedlings plant foresees the execution of a furrow, therefore the machine is not efficient in the ground very clay and stony. In fact in the Putignano plant, where the ground presented these characteristics and the settling operations had not been executed, the result of trials has been totally negative.
In conclusion we can assert that are numerous the advantages deriving from the mechanized plant, both technical-agronomic and economic.
The disadvantages, as we observed directly in field, are:

- a greater ground trampling, due to the tractors use, contrary to that happen with a manual transplant;
- the difficult to work on ground with high slope;
- the laser malfunctions with the mist, because the precision and the quality work are not optimal.

The Wagner transplanter has employed widely in the vine and olive plant, besides in the SRF (Short Rotation Forestry) the cultivation of trees woody species (poplar, willow, black locust, eucalyptus) with rapid growth and short turnover for the final production of biomasses. The technologic evolution of these transplanter typologies aims to execute the transplant operation more and more efficiently and to this purpose innovative machine, such as the Biopoplar transplanter model T3, have been patented.

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**Each author contributed in this paper in same measure**