# Contribution to the improvement of greenhouse cuttings of Rosemary: "Rosmarinusofficinalis"

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***Abstract-*** Rosemary is one of the medicinal plants traditionally used in allopathy and is also considered to have condimental and/or alimentary uses, found in Mediterranean cuisine; It is also a melliferous plant. As the demand for a continuous and uniform supply of aromatic and medicinal plants increase, the demand for a wide variety of wild species is increasing with the needs growth and the trade globalization. In order to meet the market, our study proposes a strategy for improving the rosemary success rate cuttings in greenhouses. This work objective is to study the effect of three types of substrate, as well as the effect of certain products on rosemary rooting and stem elongation in the greenhouse. To do so, we conducted an experimental protocol consisting in a total of 540 cuttings of Rosemary, grown in three types of substrates (180 cuttings for each substrate), in a greenhouse at Kenitra Faculty of Science. The cuttings are planted in plastic bags filled with three types of substrates (Substrate 1: sandy soil; Substrate 2: ½ of substrate 1 + ½ of compost and Substrate 3: 1/3 of substrate 1 + 1/3 of compost + 1/3 of peat) and placed in the greenhouse). Once prepared, the cuttings underwent a chemical treatment consisting of soaking the cuttings for 10s in 4 rooting products (willow water (ES), a 3-indolbutyric acid-based product (P1), a product based on mineral matter and amino acids (P2) and a product based on free amino acid and polysaccharides (P3)), a control was left without undergoing any treatment. The cuttings success percentage and the rosemary length stems were the main studied parameters. The obtained results showing the substrate effect on the success rate of cuttings are 44.73, 27.79 and 27.47 respectively for substrates 3, 2 and 1. Indeed, the statistical analysis revealed a significant difference between the average stem size and the average survival rate for the cuttings in substrate 3 compared to those of substrates 1 and 2.No significance was observed concerning the rooting products effect on the rosemary cuttings rate compared to the control.

***Index Terms***: Cutting, Greenhouse, rate, Substrate, Survival, Rosemary.

## I. INTRODUCTION

Rosemary is a small shrub native to the regions around the Mediterranean Sea, Portugal and Northwest Spain. Its etymology comes from the Latin RosMarinus, which means "dew of the sea" [1]. There are two important rosemary varieties: rosemary Officinalis and rosemary camphor.

Rosemary can grow up to 1.5 m in height, even 2 m in cultivation [2]. It is recognizable in all seasons by its evergreen, sessile and leathery leaves, much longer than wide, with slightly rolled edges, shiny dark green on top and whitish underneath. Their very camphorated smell also evokes incense from which it gets its name "incense tree" in Provençal [2].

**Figure 1**: Rosemary (*RosmarinusOfficinalis*) (personal photo).

Arab physicians held rosemary in high esteem and used it to treat a large number of diseases. In Morocco, the plant grows spontaneously in the open forests of the Rif, the Great and Middle Atlas. It is also cultivated in gardens as an aromatic and ornamental plant.

Morocco has very important potentialities in the field of aromatic and medicinal plants. Currently, it realizes important productions in plant material and their derived products, which confers this country a significant place on the international market [3].

Vegetative propagation is the most important method for many commercial horticultural crops [4]. This is because of the propagator ability to maintain the plant genetic integrity, whether to efficiently reproduce a superior cultivar or to provide a conforming cuttings crop. Although propagation by cuttings can be more expensive, this cost is offset by the higher value of the produced plant [5].

Our aims from this work are to improve the cuttings success rate as well as the growth rate and root development of rosemary in a greenhouse, in order to facilitate its domestication. To achieve these objectives, we proposed to study certain parameters effect, namely the substrate nature as well as some rooting products, on the survival rate and on the aerial part length of rosemary cuttings.

## II. MATERIALS AND METHODS

### A. *Vegetal material*

This study was carried out on the rosemary species (*RosmarinusOfficinalis*) belonging to the botanical family Lamiaceae. It is an evergreen shrub from 0.5 to 2 m in height. The woody stem is covered with a greyish bark and divides into many opposite branches [6].

### B. *Experimental design*

The experiment consists of budding Rosemary cuttings in a greenhouse in order to improve this plant domestication (figure 2).

To carry out our tests, an experimental set-up consisting of 180 plastic bags for each substrate (substrate 1, substrate 2, and substrate 3) was adopted.

**Figure 2**: The used experimental set-up
(1: Substrate 1, 2: Substrate 2, 3: Substrate 3)

The cutting trials were conducted in a plastic tunnel greenhouse at the IbnTofail Faculty of Science in Kenitra.

The cuttings were taken in the morning, and their length varied from 2 to 7 cm. Each cutting contains 3 to 4 nodes (figure 3). Prior to their planting, the cuttings were defoliated by reducing the number of leaves and the leaf area, in order to minimise evaporation, in addition to this, a longitudinal incision was made in the epidermis at the base of each cutting to encourage rooting.

**Figure 3**: Preparation of rosemary cuttings

To provide good shade for the cuttings, a white net is placed at 1.5 m above the cuttings inside the greenhouse (figure 4).

**Figure 4**: White net placed at 1.5m above the cuttings inside the greenhouse.

Three types of substrate were chosen to study their effects on the cuttings rooting and budding.

**Substrate 1:** Consisting mainly of Maâmora-Kénitra forest sandy soil (Kénitra, Morocco, latitude 34°15′39″North, longitude 6°34′48″ West, above sea level altitude: 13 m). It was sampled from the topsoil (0-20 cm depth) [7].

**Substrate 2:** Composed of 1/2 substrate 1 + 1/2 pine needle compost.

**Substrate 3:** Composed of 1/3 substrate 1 + 1/3 compost + 1/3 peat.

**Figure 5:** The three types used substrate

Once prepared, the cuttings underwent a chemical treatment consisting of soaking the cuttings for 10 seconds in 4 rooting products (willow water, a product based on 3-indolbutyric acid (P1), a product based on mineral matter and amino acids (P2) and a product based on free amino acids and polysaccharides (P3), the control did not undergo any treatment. The objective of this test is to promote the cuttings root development.

The tested products are different from each other in terms of the active ingredient. The following table shows the different products preparation protocol.

| Nature of the products | Preparationprotocol |
|---|---|
| Product (P1) based on 3-indolbutyric acid (IBA) | This product is used without dilution according to the product notice (0.1g of active ingredient per cutting). |
| Product (P2) based on mineral materials | We proceeded to a dilution according to the product instructions by using tap water (addition of 3ml of the product in 1 liter of water) |
| Azoxystrobinproduct (P3) | We proceeded to a dilution according to the product leaflet using tap water. (5ml of the productadded to 1 literof water) |

| | |
|---|---|
| Willow water | This consisted of cutting 5 cm fragments from a weeping willow mother plant with no specificity. For 1 kg of willow fragments we added 3 liters of tap water which we incubated for 3 weeks in the laboratory. The obtained solution will be used as watering water for the cuttings. Knowing that the obtained solution will contain a plant hormone (salicylic acid). |

All the bags are regularly irrigated, three days a week, with water from a well at the Faculty of Science in Kenitra. The trial lasted 45 days.

### C. *Measured parameters*

The measured parameters are:

- The number of cuttings budded: by direct counting.
- The length of the aerial part: by using a ruler.
- Rooting behavior: qualitative comparison between plants.

### D. *Statistical analysis*

The results obtained correspond to the average of 3 replicates. The experimental data were subjected to a one way analysis of variance (ANOVA) and the mean separations were performed by the smallest difference (LSD) at the significance level of $P<0.05$, using the Statgraphics centurion XVI program for Windows.

## III. RESULTS AND DISCUSSION

### A. Effect of substrates nature on rosemary growth

#### 1. Percentage success of cuttings

The obtained results (Figure 6) show the highest survival percentage is that of the cuttings planted in substrate 3 (1/3 substrate 1 + 1/3 compost + 1/3 peat), in fact the rosemary average survival rate is 44.72% and the budded cuttings number is 140 cuttings. For substrate 1 (sandy soil) and substrate 2 (½ substrate 1 + ½ compost), the survival percentage and the budded cuttings number are almost identical and do not show any significance. The cuttings grown on substrates 1 and 2 are significantly different from those grown on substrate 3 ($p<0.05$).

Our results have shown that substrate 3 (Soil + Peat + Compost) is more favorable for the development and regeneration of rosemary by cuttings. Indeed, based on the study carried out by [8], the obtained result can be explained by some extremely important substrate 3 physico-chemical properties, notably the water retention capacity and the oxygen availability of its components (soil, sand, peat, etc.). Different results were obtained by [9]; [10; 11], who studied the effect of organic substrates based on ground bark pieces. This study showed that the coarser particles increase the air porosity of the medium by increasing the proportion of macro-pores.

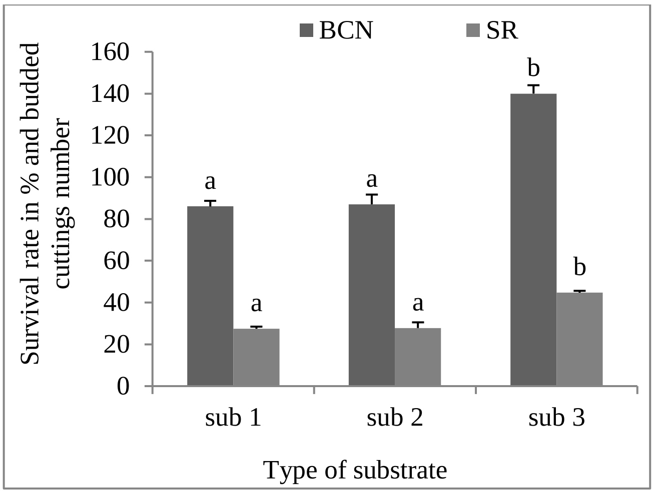


**Figure 6:** Survival rate variation in (%) as well as the budded cuttings number according to the substrate type. (BCN: Budded cuttings number; SR: Survival Rate in %) (Values with different letters are significantly different ($p<0.05$))

#### 2. The aerial part development

The aerial part evolution results (figure 7) showed an important variation in the stem length of rosemary cultivated in substrate 3, in the time course compared to that of substrates 1 and 2. Indeed after one week, the rosemary stem length recorded an average of 3.37; 4 and 5.82cm for sub, sub2 and sub3 respectively (figure 7).

After the 5th week, the rosemary stem length in substrate 3 reached an average length of 13cm, while the average length of the cuttings in substrate 2 was 8.16cm and that of the plants in substrate 1 was 7.25cm.

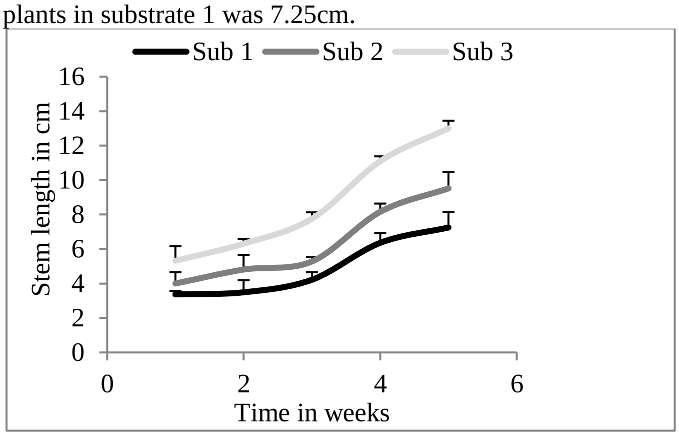


**Figure 7:** Substrate effect on rosemary stem length development

In terms of comparison between the plant stems length in the three substrates types, we found that, according to the statistical analysis, there is no significant difference between the average stem length of the plants grown in substrates 1 and 3 compared to substrate 2. Whereas there is a significant difference between the average length of the plants grown in substrate 1 and substrate 3 (figure 8). This difference can be attributed to the optimal proportion of organic matter contained in substrate 3. Indeed, due to the compost and peat richness in organic matter, the soil capacity to retain water and nutrients increases [12]. Consequently, the calcium contained in the compost favors flocculation and the association of colloids to form the clay-humus complex, which is essentially negatively charged, attracting the macro-elements (K+, Mg2+, Na+) contained in the compost.These macro elements represent 99% of the plant dry matter [13] and therefore contribute to the rosemary stem growth. Similar results were found in a study conducted by [14], which approved peat and compost beneficial effect as a growing medium for the cultivation of young plants in the greenhouse.

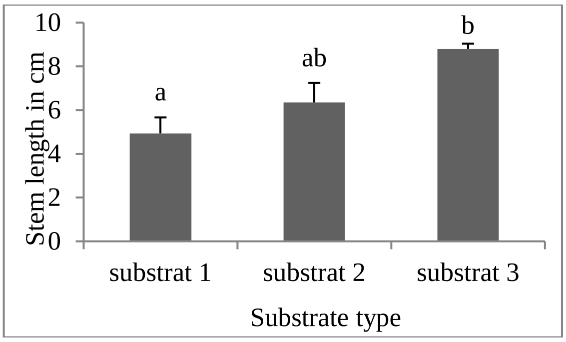


**Figure 8:** The rosemary stem length evolution according to the substrate type.

(Values with different letters are significantly different ($p<0.05$))

The results relating to the stems length have shown a great diversity in the aerial part morphology. As illustrated in the pictures in figure 9, there is a clear difference between the cuttings cultivated in the three substrates.

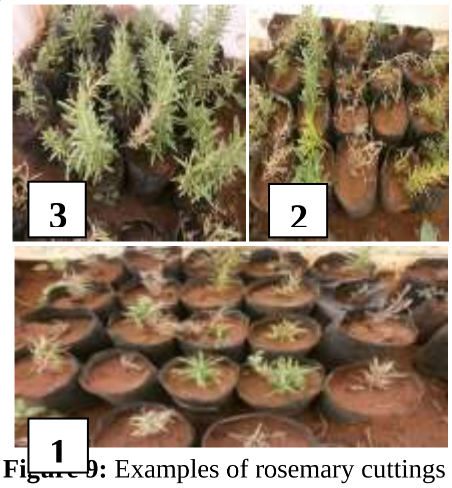


**Figure 9:** Examples of rosemary cuttings planted in different substrates

1: Substrate 1  2: Substrate 2  3: Substrate 3

It was found that the cultivated cuttings in substrate 3 gave optimal results regarding leaves quality and quantity as well as the stem growth rate and size, while for the cultivated cuttings in substrate 1 and 2 the aerial part length is less important as well as the growth rate which is too slow (figure 7).

*3.* Substrates effect on the root system development

Concerning the substrate effect on the root system development, it was found that substrate 3, composed of soil, peat and compost, allowed the rosemary a good rooting. Indeed, in figure 10, we can clearly notice a significant roots development and length of the rosemary cultivated in the substrate 3. This can be attributed to the peat benefits, since it contributes to reduce certain types of stress [15] and increase soil porosity. Similar studies have shown that low air porosity is generally associated with weaker root growth [16, 17, 18, 19].

**Figure 10:** The rosemary root system for the three substrates types.

B. Rooting products effect on the rosemary development

1. Stem length

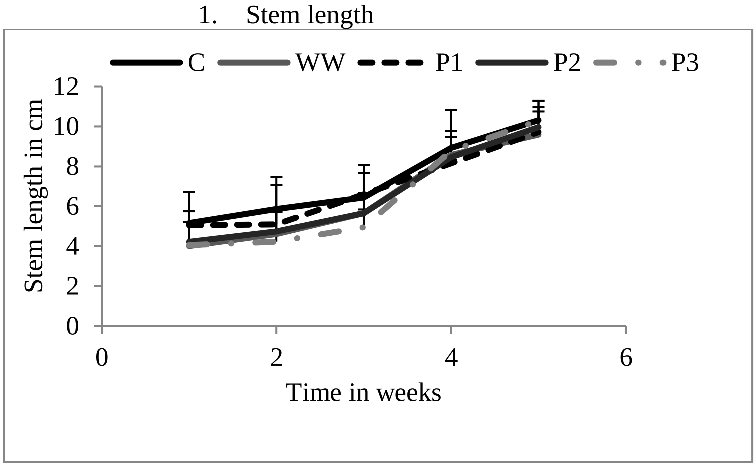


**Figure 11:** Treatment type effect (C: control; WW: willow water; P1: IBA-based product; P2: mineral-based product; P3: mineral, amino acid and polysaccharide-based product) on the rosemary cuttings aerial part length over time in weeks.

Figure 11 illustrates the rosemary cuttings stems length evolution that underwent the four treatments versus time.

After the first week, the rosemary aerial part length reached an average of 5.16 cm for the untreated cuttings, while the aerial part length of those treated with P1, P2, P3 and W.W is 5.05, 4.22, 4.06, 4.01 cm respectively.

After the 5th week, the all treated cuttings stems length is almost the same, it averages 10 cm.

2. Cuttings successful percentage

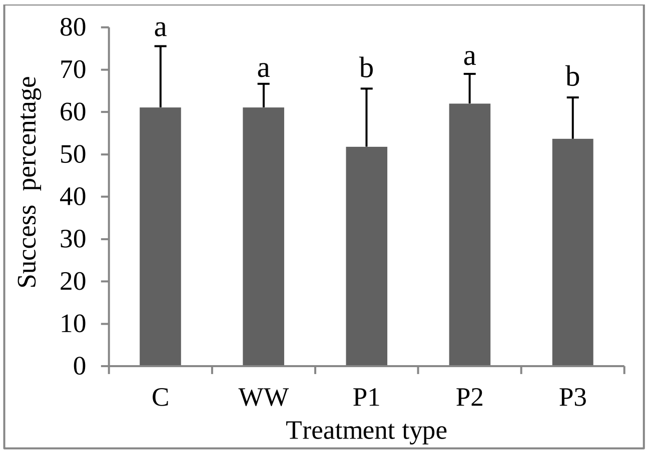


**Figure 12:** Treatment type effect (C: control; WW: willow water; P1: IBA-based product; P2: mineral-based product; P3: mineral, amino acid and polysaccharide-based product) on the rosemary cuttings survival percentage.
(Values with different letters are significantly different ($p<0.05$))

For the rosemary cuttings survival percentage object of the four treatments (WW, P1, P2, P3) (Fig 12), it has been noticed that the control and the WW and P2 treatments present a similar success rate (60%) which is significantly different from that of the cuttings having undergone the P1 and P3 treatments (50%). In terms of comparison between the four treatments and the control, it can be seen that the rooting products did not improve the success percentage compared to the control. This can be explained by the richness of the three substrates in fertilizing elements present in the rooting products.

### C. Discussion

The cutting technique presents several advantages, which are summed up in the faithful reproduction of the mother plant characteristics in thousands of individuals, all of which are homogeneous in their growth [20, 21]. Moreover, plants produced by cutting technique are characterized by faster growth compared to plants produced by seedling.
The substrate quality is one of the most important criteria among those which have an influence on the cuttings growth [22]. A good substrate has a set of physical and chemical properties that condition good and fast plant growth [23, 24].
The obtained results have shown that the rosemary cuttings survival percentage is significantly important in substrate 3 compared to the other substrates. Likewise, substrate 3 (1/3 sandy soil + 1/3 compost + 1/3 peat) allowed to obtain a branched and more developed root system. Similar results are confirmed by other authors [25, 26]. Indeed [27] have observed that the rooting of plants cultivated in culture supports such as peat, Loire sand, vermiculite had aspects that differed according to the nature of the substrate.
Some works have shown that sylvicultural compost has given excellent results in matter of substrates manufacturing to produce seedlings, among others, in in forest and horticultural nurseries [28, 29]. Furthermore, according to [30] silvicultural compost substrates have shown satisfactory morphological and physiological characteristics for cultivated plants. Also,[31] found that humic substances obtained by composting are increasingly used in intensive production in nurseries and greenhouses to improve soil fertility and structure.
Depending on the presence or absence of compost, situations vary greatly from one territorial collectivity to another, and there is very little compiled data on the composts use [32; 33]. Furthermore, the composted products use in the horticultural substrate sector remains low: the sale of composts is only possible if the composting platform is present within a limited radius around the substrate production site [32]. In addition, many substrate producers and horticulturists still prefer to use peat-based growing media: its hydric characteristics, physical and biological stability are all qualities sought by horticulturists [34].
It should be noted that [35] report that white peat can have a correct behavior at the beginning of rosemary cultivation, and then becomes a very unfavorable asphyxiating medium for the roots. Thus, it appears that a substrate physical behavior is more important than its chemical composition [36; 37].
For stem length, it was found that the rosemary in substrate 3 allowed an optimal stem development with a very high growth rate compared to other substrates, which is confirmed by other authors [38]. On the other hand [39] revealed the beneficial effect of peats as a growing substrate for rearing young plants in nurseries and even after planting. Similarly, several studies have shown the effectiveness of using compost mixed with peat as a growing medium for plants production in nurseries [40, 41, 42, 43]. Any material used in the composition of a culture support must meet a number of physical and chemical characteristics that prove its aptitude to allow plant growth [44]. In the same sense, some studies have shown that substrates with low air porosity are generally associated with weak plant growth [45, 46, 47, 48]. However, other studies have not been able to link air porosity with plant growth [49, 50].
Concerning the rooting products effect on rosemary cuttings, it was found that the rooting products did not significantly improve the cuttings successful percentage and the stems size compared to the control plants, which reflects the three types of substrates richness in nutrients (macroelements) necessary for plant development. Indeed, the macro-nutrients mainly N, P, K, Ca and Mg, which are the major growth elements and necessary for the development of the plants[51], are found in abundance in the compost and in the peat.

## IV. CONCLUSION

Rosemary propagation by cuttings has led to an improvement in tunnel greenhouse cuttings, as well as saving money and time, the success of cuttings varies according to the species.
The present work allowed us to identify the effect of some substrate type as well as of some rooting products on the survivability of rosemary and also on the length of the aerial and root part.
The substrate composed of soil-compost-peat allowed to obtain satisfactory results both in terms of quantity and quality of the rosemary aerial and root parts, which could be attributed to the drainage and the necessary aeration ensured by the used substrate. Likewise, this substrate allowed a

higher survival percentage of the cuttings compared to the other two types of substrates.

According to the obtained results, we can conclude that the best substrate for rosemary cuttings is a sandy soil-compost-peat, which is a porous and light substrate. It has a good water retention capacity and at the same time allows a good water and oxygen circulation to the roots of the cuttings.

The obtained results concerning the rooting products effect on the rosemary budding rate did not present any significance compared to the controls, which can be explained by the richness of the three substrates in fertilizing elements that the rooting products contain.

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