

## **EXPERIMENT ON PINUS PINEA SEEDLING USING HYDROGEL WITHIN THE LEBANESE CLIMATE CONTEXT**

An experiment was initiated in Lebanon using a well known and planted type of trees which is scientifically known as *Pinus Pinea* and commercially as the Stone Pine. This type of plant was specifically selected for this experiment due to its economic, cultural, environmental value and geographical presence in different micro climatical Lebanese zones covering a large space across the country. The experiment focused on testing the use of Hydrogel during the plantation phase will help increase the rate of the seedlings survivability facing both, the high temperature and prolonged drought phase that is dominating the Middle East due to the climate change in the region.

In order to eliminate any weather or soil condition that may affect the study, it has been decided to implement the study in on geographical area in Lebanon that is so representative of the whole county both climatological and geological situation. Seedling age was chosen same to as what usually be used during a reforestation process where seedling aging between 1 to 2 years old are selected for the process; In addition, the age factor was taken into consideration in this study by dividing the experiment into 2 big groups based on the age, with first group containing only seedlings that are one years old, and second one of two years old. Seedlings were divided not only into two main groups, but also each group was divided into 7 lines, and each line consisting of 10 seedlings. Each line in both two groups was noted from T0 till T6, where each line was treated and approached in a different way than the others. In other words, the experiment consisted of a total of 140 seedlings that are divided equally., into first group containing 70 seedlings of 1 years old and second group containing seedlings of 2 years old. Each group then is divided equally into 7 lines with 10 seedling per line to have results that be statistically significant.

The first line known as T0 was used as the control line, where no hydrogel or water been added to the seedlings in both group year 1 and year 2.

The second line known as T1, was approached only during plantation phase by adding only 5L of fresh water, and without any addition of hydrogel in both groups aged 1 and 2 years old.

The third Line known as T2, both groups aged 1 years old and 2 years old were approached during plantation by being watered with 5L of

fresh water and 0.1g of granular hydrogel, with repetition of watering every 15 days with 5L of fresh water.

The fourth line known as T3, both groups aged 1 years old and 2 years old were approached during plantation by being watered with 5L of fresh water and 0.2g of granular hydrogel, with repetition of watering every 15 days with 5L of fresh water.

The fifth line known as T4, both groups aged 1 years old and 2 years old were approached during plantation by being watered with 5L of fresh water and 0.3g of granular hydrogel, with repetition of watering every 15 days with 5L of fresh water.

The sixth line known as T5, both groups aged 1 years old and 2 years old were approached during plantation by being watered with 5L of fresh water and the rooting system was exposed after removal of soil attached to the roots, followed by 3 repetitive submersion of each seedling in a pre-prepared hydrogel solution, allowing by that some of the gel to colloid to the rooting system before plantation, and with repetition of watering every 15 days with 5L of fresh water.

The seventh line known as T6, both groups aged 1 years old and 2 years old were approached during plantation by being watered with 5L of fresh water and 0.75 g of granular hydrogel and 0.75 of fertilizer (nitrate), with repetition of watering every 15 days with 5L of fresh water.

The Hydrogel solution that is used for submersion in the sixth line was prepared using a mix of only granular dry hydrogel with fresh water, the hydrogel/water used for this experiment was based on the hydrogel's manufacturer recommendations.

Before plantation, the chosen plot was fenced to eliminate any animal or human interaction with the seedlings, the soil was cleared from any weeds or small shrubs that may affect the seedlings, holes with 40 cubic centimeters homogenic dimensions were excavated creating a separation of 1 meter interlines, and 1 meter inter seedlings. The holes were excavated 3 days prior to plantation, making sure that the soil will get enough aeration and sunlight avoiding any potential of fungal contamination.

During Plantation, the seedling were planted same day going line by line in both 1<sup>st</sup> and 2<sup>ng</sup> age group, starting from first line T0 finishing by the seventh line T6 to avoid any errors and confusion. Hydrogel and fertilizer quantities were measured prior to plantation day and preserved in small, labeled capsules. Water volume was measured using a graded water bucked. Seedling were brought in plastic bags, and those bags were removed while keeping on the soil covering the rooting system before plantation, except for the sixth line known as T5, were the soil was removed in prior to dipping in the hydrogel solution. Dry granular hydrogel used in T2,

T3, and T4 was emptied in the bottom of the excavated holes directly prior to placing the seedlings in the holes; Same for the mix of hydrogel and fertilizer used in T6. While first line T0 seedlings were planted by simply adding and pressing by feet the soil to cover and level up the holes after placing the seedlings in the center of each hole, the soil in other lines was added in two steps in order to allow pouring the first half of the designated water for irrigation for each seedling in each hole after the added soil reaches up half the hole, and the rest after the added soil reaches the top of the hole and is leveled up with the soil surface. This traditional approach is used during plantation to ensure that there is water availability to the rooting system during and directly after plantation, and to avoid any air gaps that may negatively affect the rooting system.

The seedling height and trunk diameter was measured and recorded on the 30 of June 2022, the day of plantation, and same process repeated on the 30<sup>th</sup> of December 2022. In addition, the seedlings health and conditions were monitored and recorded each 15 days since the day of plantation prior to conducting the scheduled watering.

Based on the observations noted from the frequent visits, and the measurements a full analysis was conducted using qualitative and quantitative approaches with the help of statistical methods and the following was observed and concluded:

One year old seedlings: The effects of different type of treatments on plants can be seen by visual comparison of the distribution of plants' status as at 30Sep (after 4 normally dry months in Lebanon's seasons). We can conclude that although treatment T5 (dipped in gel) was better than no treatment of maintaining the plants' health, it was the least effective compared with other treatment types.

Two year old seedlings: It's interesting to observe that older plants didn't help much with their survival in the control group (T0), as well as plants with treatment T5. Treatments T4 and T6 had one tree dead each. As the sample size was quite small (10 trees in each group) we suspected that this was just a random chance, not statistically significant.

The ANOVA statistical method was used to evaluate which treatments (T2, T3, T4, T5 and T6) have a significant effect on the seedlings, and based on that we concluded:

First, the ANOVA showed the six treatment types have significantly different means/averages of plant growth (with p-value < 0.05).

Second: treatment T6 was the most effective method for plant growth in each group of the age of plants.

Third, one-year old plants with treatment T6 had much higher average growth than two-year old plants with the same treatment.