Soaking Germinated Oil Palm Seeds in Transit Kelp® to Assess Shoot and Root Response

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Oil Palm trees are the most popular edible vegetable oil crop in the world (Aba and Paul, 2012). Known for its high oil content and efficiency, palm oil a common ingredient in many foods and other goods such as soaps and cosmetics (Gesteiro et al., 2019). However, due to the increasing demand for palm oil, the industry is facing social and environmental issues surrounding the sustainability of palm oil production and are exploring routes to improve continuously improve the efficiency of Oil Palm trees to match global demand. One way to do this is through improvements in shoot development and increasing root exploration and development to provide young Oil Palm seedlings with a strong base to grow and promote the absorption and utilization of nutrients more efficiently. This trial was done to assess if soaking pre-germinated Oil Palm seeds in 2% and 20% solutions of Transit Kelp® will increase shoot and root development compared to a control. It was found that though soakings of Transit Kelp®, there was noticeable increases in shoot height compared to the control and also increases in root length compared to the control. It was also noted that seeds soaked in Transit Kelp® produced more lateral roots increasing the surface area of the root system.

Key words: Oil Palm, pre-germinated seeds, Transit Kelp®, plant height, root length, lateral roots

Introduction

Oil Palm *(Elaeis guineensis)* trees are grown for the harvesting of the edible vegetable oil known as palm oil (Gesteiro et al., 2019). The palm oil is extracted using 2 different methods which utilize different parts of the palm seeds. These 2 methods created 2 different types of oil known as palm oil and palm kernel oil. Palm oil is traditionally used for edible purposes such as cooking, frying and as a food ingredient. Palm kernel oil is generally used for non-edible purposes such as the formulation of soaps, cosmetics and detergents (Chin, 2019).

For many years Palm Oil has been the most popular vegetable oil as it is the highest yielding vegetable oil crop which makes it very efficient and very popular. Another advantage is it requires much less land compared to other vegetable oil crops in order to produce the same amount of oil. Together, these advantages make oil palm production the most attractive vegetable producing crop also making it the least expensive vegetable oil in the world.

Oil Palm plantations are most commonly seen in the tropical zones around the equator where there is ample rainfall and warm weather. This tropical weather makes it a prime location for high yielding Palm Oil production. Indonesia produces the most Palm Oil with approximately 33.4 million tonnes produced annually, followed by Malaysia and Thailand. Indonesia and Malaysia make up approximately 84% of the market share (Which countries grow and produce palm oil?, 2015). However, over recent decades, there has been a strong increase in the demand for edible vegetable oil and a result, Palm Oil plantation have had to expand rapidly in order to reach global demands. This increase in demands has significantly contributed to economic growth and poverty reduction in these countries, however many social and environmental issues have arisen related to the sustainability of the crop such as land degradation and deforestation (Qaim, Sibhatu, Siregar and Grass, 2020). Research and development is currently underway to explore avenues to further increase the efficiency of the Palm Oil trees to make more oil, make cultivars which are more suitable to arid environments where space is plentiful and also improve growing traits.

One way the efficiency of Palm Oil production can be increased is by reducing seedling mortalities, increasing shoot development and improving root exploration and development. By making improvements to the initial stages of growth from the germination of the Palm Oil seed to the development of the eophyll (first palm frond), seedlings can be transplanted quicker into the field and also have a better capability to absorb nutrients and accelerate growth making the palms more efficient and possibly shortening the time to first fruit production.

Dual Chelate Fertilizer has created a highly pure kelp enriched bio-stimulant – Transit Kelp. Transit Kelp contains 8% highly concentrated kelp derived from the *Laminaria japonica*. This variety of kelp is high in the plant growth hormone Cytokinin which is involved in promoting cell division and root apical dominance.

In this study Transit Kelp® will be applied to germinated Palm Oil seeds through soaking in an effort to compare the development of the initial root system and shoot growth. Two different concentrations of Transit Kelp® soaking solutions will be used to examine any responses to the bio stimulant and then compared to control germinated Palm Oil seeds. Shoot height, root length and plant structure will be analyzed.

Objectives

1. Assess shoot growth and root system developmental differences between each Transit Kelp® soaking solution concentration (2% and 20%) against the control.
2. Measure shoot length, root length and take images of young Oil Palm seedlings 1 month after initial soaking.
3. Visually compare the treatments to see any difference in appearance.
4. Determine if Transit Kelp® is a beneficial product to use to improve the initial growth of Palm Oil seedlings.

Site Selection and Trial Design

The trial will be conducted in the greenhouse located at Dual Chelate Fertilizer. This site was selected as Oil Palms needs warm, humid and wet conditions. These conditions can be simulated using an irrigation sprinkler system to ensure that the germinated seeds do not dry out. Each pre-germinated Palm Oil seed is planted in its own individual.

In total, there will be 2 different seed soaking solutions of Transit kelp® with concentrations at 2% and 20%. In each treatment there is 12 germinated Palm Oil seeds which are soaked for 12 hours before planting. See figure 1 for a diagram of the trial set up.

Figure 1: Soaking of germinated Oil Palm seeds in various concentration of Transit Kelp®. Germinated seeds were soaked for 12 hours then planted.

Once the seeds had been soaked for 12 hours in their respective solutions, the seeds were then planted root first in soil and covered with vermiculite to prevent moisture loss. The soil was collected from the vineyard at Dual Chelate fertilizer and is free from any nutrient contaminations. See figure 2 for the pot layout for the three different treatments (2% Transit Kelp®, 20% Transit Kelp® and control).

Figure 2: Pot set up of germinated Oil Palm seeds. each treatment has 12 pots with a single seed planted in each pot

Once the Oil Palm seeds were planted, they were kept moist every day with short and frequent sprinkling. After 1 month, each plant was measured for its shoot height. The first plant from each treatment was also carefully dug up to examine the root system and measure the root length. One plant was examined as this experiment is on-going and will be again measured after 2 months.

Application Rates

Table 1: Application rates of different soaking solutions at 2% and 20% Transit Kelp®). 12 Germinated Oil Palm seeds are soaked in each treatment for 12 hours then planted.

Treatment	Amino Boost Transit Max®	Water
2% Transit Kelp	4ml	200ml
20% Transit Kelp	40ml	200ml
Control	0ml	200ml

Observations

Shoot Height

Each plant was measured for its shoot height using a ruler after 1 month of growth. The shoot height is measured from the start of the root to the tip of the first palm frond (eophyll). Oil Palm seeds which did not grow was discounted from the measurements and not used when averaging the results for each treatment.

Root Length

The first plant from each treatment was then uprooted carefully and dirt was washed off. The longest root was then measured and photographed.

Comparative Photos

Comparative photos were taken to visually compare plant growth of the plants which were dug up to assess root quality and root length.

Results

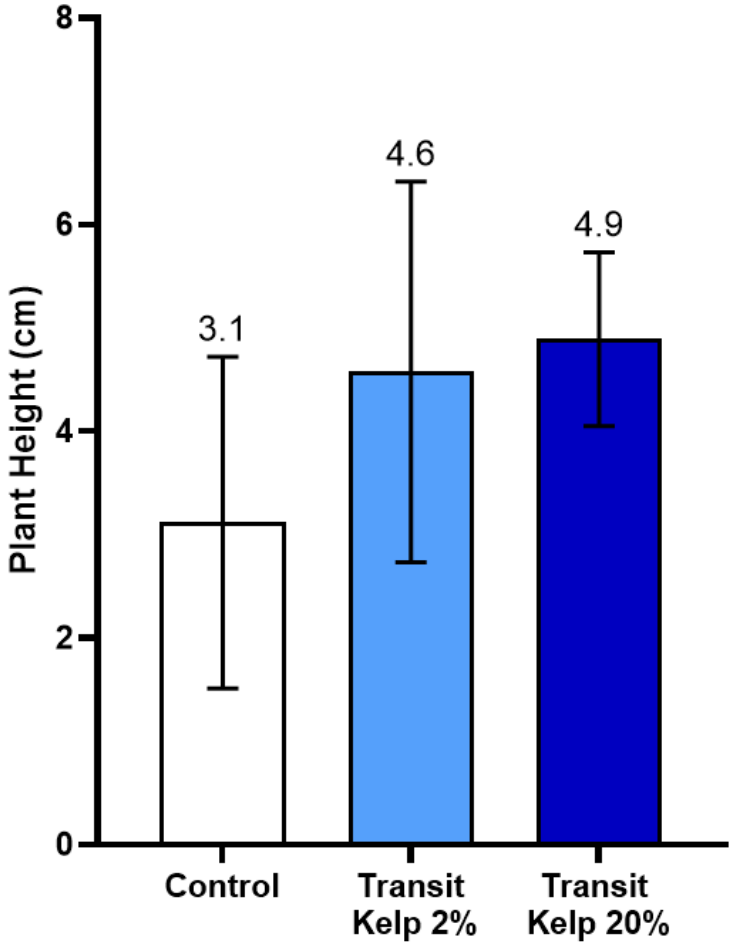

Figure 3: Average plant height of germinated Oil Palm seeds soaked in Transit Kelp 2% and Transit Kelp 20% solution. Plant height was taken 1 month after planting.

Table 2: Root length of Oil palm seedlings (cm)

Treatment	Root Length of 1 Plant (cm)
Control	8.1 cm
Transit Kelp® 2%	10 cm
Transit Kelp® 20%	10.5 cm

*Figure 4: Image taken of germinated Oil Palm seedling soaked in a **2% Transit Kelp®** solution before planting for 12 hours compared to a control seedling. Photo taken one month after planting.*

*Figure 5: Image taken of germinated Oil Palm seedling soaked in a **20% Transit Kelp®** solution before planting for 12 hours compared to a control seeding. Photo taken one month after planting.*

Discussion

When looking at figure 3, it can be seen that both the 2% and 20% Transit Kelp® treated Oil Palm seeds had taller shoots compared to the control. With a significant increase seen between the control and the 2% Transit Kelp® showing that Oil Palm seeds soaked in 2% Transit Kelp® solution had a 48% increase in in plant height. However, there was only a 58% increase in plant height from the control to the 20% Transit Kelp® solution showing that there is not much of a difference between the 2 and 20% solutions.

Transit Kelp® is rich in the plant growth hormone Cytokinin, this may be the reason why there was a sharp increase in shoot height from the control to the 2% and 20% solution. Cytokinin helps with new cell development and apical dominance which explains the sharp increase in plant height as the Cytokinin would drive the production of new cells in the shoots (Feng, Shi, Yang and Zuo, 2017). Transit Kelp® also contains amino acids, nitrogen, phosphorus and potassium which also support in the new growth increasing the plant height (Ruban and Govindasamy, 2018). The nitrogen is essential for building the proteins to assist and maintain the new development of leaves and shoots, the phosphorus assist in making sure the Oil Palm seedlings have a quick healthy start by promoting photosynthesis, nutrient transport and energy transfer, potassium works by activating many key enzymes and regulates many essential processes in the plant such as water use efficiency and protein synthesis.

Table 2 shows the root length of Oil Palm seeds soaked in Transit kelp® compared to the control. It can be seen that there is a similar trend seen in the plant height results where there is not much of a difference between the 2% and 20% solution, however there is a large difference compared to the control. Oil Palm seeds soaked in Transit Kelp® before planting show to have a positive increase in root length by approximately increasing the root length by 27% compared to the control. When looking at figure 4 and 5, it visually shows the increases in root length compared to the control where both Transit Kelp® treated Oil Palm seeds have longer root systems compared to the control. In addition to the longer primary root, there is also more lateral root development, specially in the 2% Transit Kelp Solution. In the 20% Transit Kelp® solution, there is also some lateral root development but it is more situated at the top of the primary root whereas the 2% solution shows lateral root development further down the primary root. In previous research, it has been shown that Transit Kelp® significantly increases the root length and also the number or root hairs and later growth of roots in young germinating Soybeans. This is because of the cytokinin based kelp has a direct effect on root apical dominance. This increase in apical dominance drives the main root deeper into the ground producing a longer root which is seen in both 2% solution and 20% solution.

Conclusion

In conclusion, this trial was conducted to assess the shoot and root response to soaking pre-germinated Oil Palm seeds in 2% and 20% solutions of Transit Kelp® for 12 hours. Both treatments showed that there was a positive response to the soaking of the seeds 1 month later by increasing plant heigh and also increasing root length whilst also improving lateral root production from the primary root.

When studying the figures and tables presented above, it can be found that Oil Palm seeds soaked in 2% and 20% Transit Kelp® solution for 12 hours had the following improvements compared to Oil Palm seeds soaked in water:

- Increased the plant height from 3.1cm (control) to 4.6cm (2% solution) and 4.9cm (20% solution)
- Increased root length from 8.1cm (control) to 10cm (2% solution) and 10.5cm (20% solution)
- Improved the root length and promoted the formation of lateral root development on seeds soaked in Amino Boost Transit Max® compared to the control.

This trial is still under observation with a second application of 2% and 20% Transit Kelp® solution being applied to the Oil Palm seedlings after 1 month of growth. After 2 months, shoot height and another analyses of root growth will be done to assess the further benefits of using Transit Kelp® to help increase establishment of Oil Palm seeds.

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Appendix 1

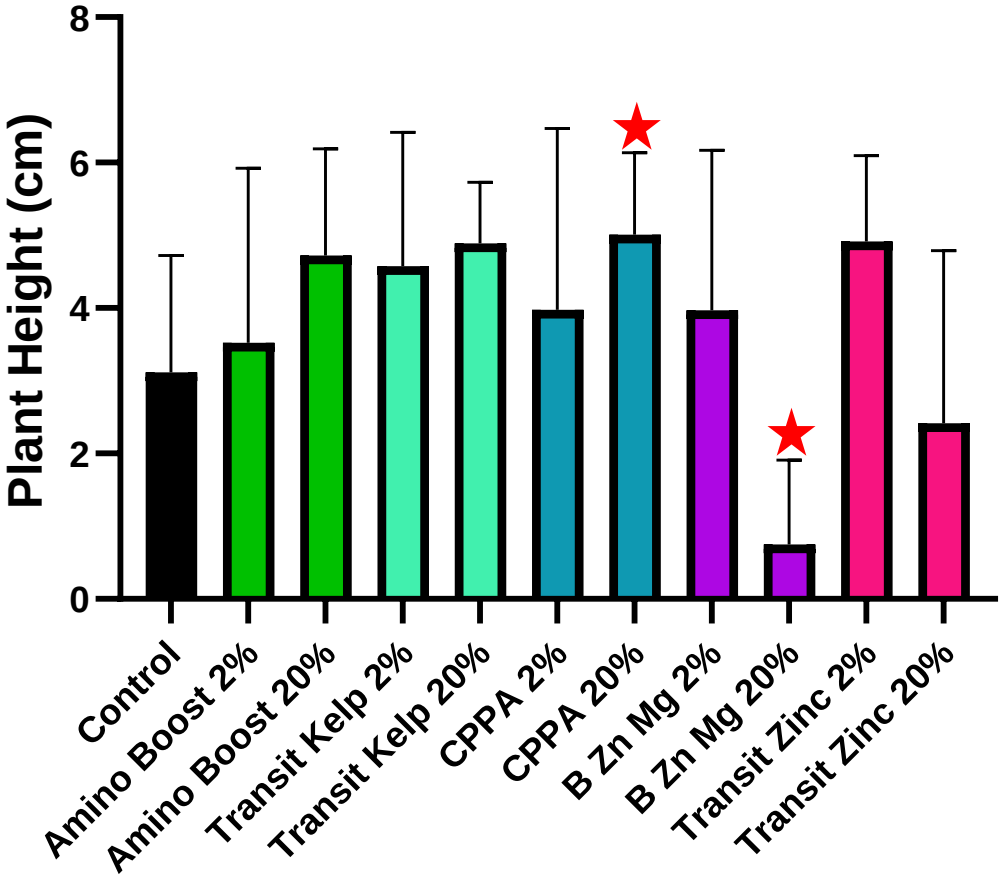

Figure 6: The plant height measurements taken from all treatments in the experiment. Red stars indicate statistically significant treatments