Evaluating the Benefits of Transit Kelp® Against other Commercial Kelp Fertilizers to Assess Shoot and Leaf Development

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Kelp is a type of seaweed that grows in nutrient-rich, shallow saltwater. It is rich in nutrients including vitamins, minerals, antioxidants, and plant growth regulators. Also, it includes Alginic acid and Amino acids which help is stress relief and provide building blocks for proteins (Černá, 2011). Kelp contains cytokinin as plant growth regulator and cytokinin is important for cell division and apical dominance (Taylor, Harker, Robertson and Foster, 1990). Therefore, kelp is crucial for shoot growth and overall plant growth. In agriculture, there are many varieties of kelp bio-stimulants on the market however they are not all equal in terms of composition and effectiveness. This trial was done to assess the different commercially used kelp bio-stimulant fertilizers against Dual Chelate Fertilizer® Transit Kelp® to assess differences in shoot and leaf development using Soybeans. It was found that soybeans treated with Transit Kelp® were the tallest in plant height, was the most effective at maintaining chlorophyll levels and managing stress even when subjected to nutrient stress, had the highest shoot weight out of all treatments, produced the thickest stems and also visually had larger leaves, taller stems, and less leaf yellowing.

Key words: Kelp, plant growth regulators, soybeans, stress relief, shoot growth, overall plant growth.

Introduction

The addition and use of kelp in fertilizers has been a popular choice amongst the agricultural industry, especially in horticulture, as a bio-stimulant which enhances plant nutrient uptake and helps reduce plant stress to conditions such as droughts, frosts and water deficit areas (Khan et al., 2009). Kelp has been proven to have high levels of plant growth stimulants (hormones) such as cytokinin and auxin which together help plants in creating new growth in their shoots and roots promoting the uptake of key macro and micro nutrients. In conjunction with growth stimulants, kelp also has a diverse range of macromolecules and compounds such as proteins, amino acids and carbohydrates which all greatly assist in numerous plant growth areas (Nabti, Jha and Hartmann, 2016). As kelp becomes a more popular choice amongst Australian agriculture, it is extremely important to understand the direct benefits towards the Australian horticultural sector. This study is focused on comparing different commercially available kelp and seaweed plant bio-stimulants in an effort to show case Dual Chelate Fertilizer Transit Kelp® as a premium and more advanced bio-stimulant formulation in comparison to other commercial kelp/seaweed brands in order to promote shoot growth.

Australian agriculture is constantly being hindered by stressors such as high demands for horticultural goods, unfavourable weather conditions such as heatwaves, droughts and frost and also having to battle against extreme water limitations. These stressors can cause severe damage to crop yields and also reduce farm return on investments (Francini and Sebastiani, 2019). The use of kelp is now being adopted amongst farmers in the irrigation sector. 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 formulation is highly refined and highly pure making it a premium product for both foliar and fertigation in horticulture.

In this study, different soil kelp and seaweed products will be applied to soybeans in an effort to compare their direct effect on shoot growth and development. 5 different kelp products, including Transit Kelp will be applied to soybeans and compared to assess shoot weight, shoot height, stem thickness, number of pods and average chlorophyll levels. Periodic photos of the treated soybeans will also be taken to visually compare growth. Graph pad prism 9 will be used to statistically analyze the results.

Objectives

1. Assess the differences observed between each different kelp products on shoot and leaf development
2. Measure fresh shoot weight, shoot height, stem thickness, number of developed pods and average chlorophyll levels.
3. Visually compare the soybeans weekly to see any difference in appearance.
4. Determine which kelp product is the most effective on plant growth in terms of shoot and leaf development.

The outcome of this trial will assist in showcasing the direct benefits of Dual Chelate Fertilizer Transit Kelp® in comparison to other competitive seaweed/kelp fertilizer products.

Materials and Methods

Site Selection and Trial Design

The trial will be conducted in the greenhouse located at Dual Chelate Fertilizer. This site was selected as this trial will be undertaken using hydroponics as the trial will need to be monitored daily for measurements and kelp applications.

In total, there will be 5 different treatments of kelp bio-stimulants, Transit Kelp® and 4 other commercially available seaweed/kelp products. For each of the treatments there will be 3 replications of each treatment and 3 plants in each replicate to allow for accurate statistical analyses (see figure 1 for trial layout). A control will not be used as it won't provide an accurate comparison between treatments. Below shows the layout for this trial.

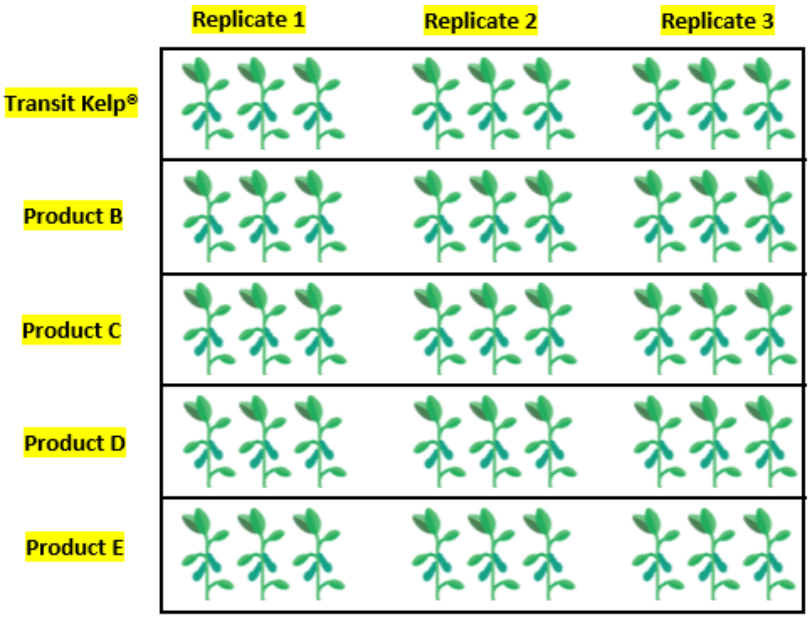

Figure 1: Trial set up comparing various kelp/seaweed treatments on Soybean's (Glycine max).

The trial will be run over the span of 1 month with treatments being applied to the Soybeans every 3 days. The reason the application rate is high is because a positive reaction is going to be induced to see the direct effects that different commercial kelp has on growth.

The medium used to plant the soybeans in is vermiculite. This substance will allow for easy root exploration and also allow the plants to be removed and examine without damage. Vermiculite also has no added nutrients which stops any variable factors which other potting mediums such as potting mix may have. It is important to note that since the Soybeans only had applications of kelp and no other added nutrients, the soybeans were chlorotic towards the end of the trial as they were very nitrogen deprived.

Application Rates

Table 1: Application rates of different commercial kelp products. Names of the commercial products cannot be disclosed due to legal reasons.

Kelp Treatment	Application rate
Transit Kelp®	**0.137ml/pot**
Product B (Ax)	**0.005g/pot**
Product C (Sx)	**0.33g/pot**
Product D (Fx)	**0.027g/pot**
Product E (Nx)	**0.0687 g/pot**

The application rates of each kelp product were based on the application rate on the respective labels. The rate was the used to work out how much kelp needed to be applied to each pot. Every 3 days kelp was applied to the pots with the rates highlighted in the table above.

Observations

Measurements will be taken once a week. Measurements include plant height measurements and average chlorophyll measurements. At the end of the month, shoot weight, stem thickness and number of pods will be analysed.

Plant Height Measurements

Every 3 days, each Soyabean will be measured to record their plant height. This is the height from the soil medium surface to the tallest leaf using a ruler.

Average Plant Chlorophyll Levels

Every 3 days, a handheld SPAD meter will be used to analyze each leaf on each soybean plant. Once each leaf has been analyzed, the readings will be averaged to gain a whole plant chlorophyll analysis. This is done for each plant.

Shoot Weight

At the end of the experiment, each soybean will be uprooted and the point where the shoot turns into root will be cut. The shoot will then be weighed as fresh weight to get the whole shoot weight.

Stem Thickness (stem diameter)

At the end of the experiment, stem thickness will be measured from each soybean plant. To keep a consistent measurement, the stem thickness (stem diameter) will be taken half way between the base of the stem and the first node. A stainless steel caliper will be used to measure the dimeter of the stems.

Number of Developed Pods

At the end of the experiment, the number of developed pods per plant will be counted and added together to get a total number of pods for each treatment.

Comparative Photos

Once a week, progress photos of the soybeans will be taken to assess the growth and overall development of each plant against other treatments.

Results

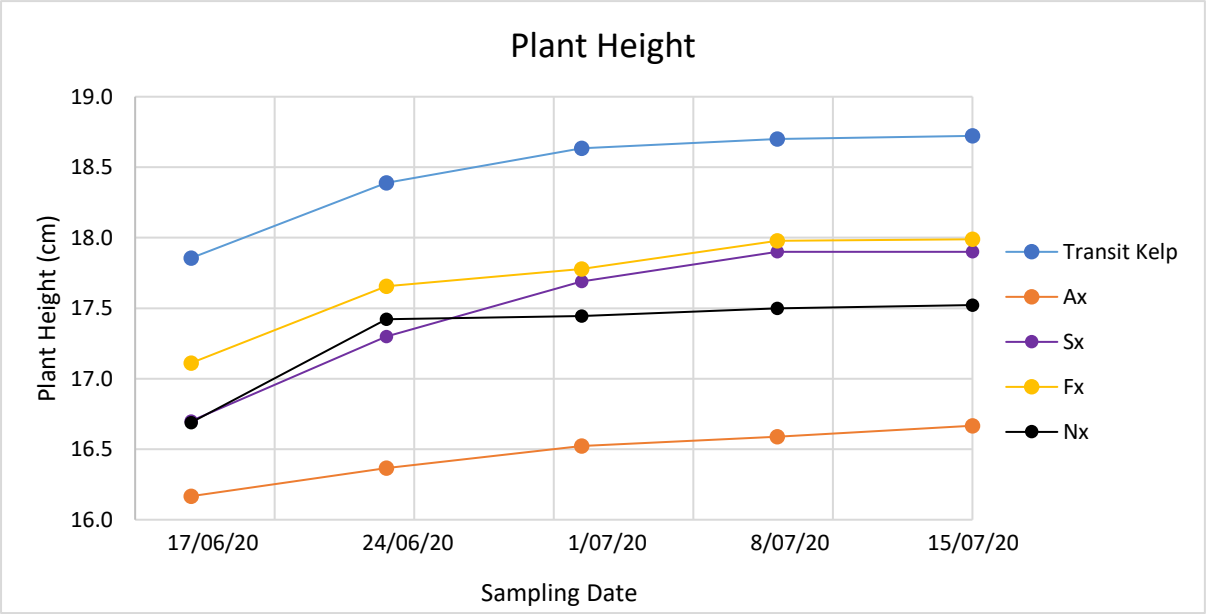

Figure 2: Average plant height (cm) measurements of soybeans treated with different types of kelp. Measurements were taken weekly and averaged. Other treatments besides Transit Kelp® cannot be displayed for legal reasons.

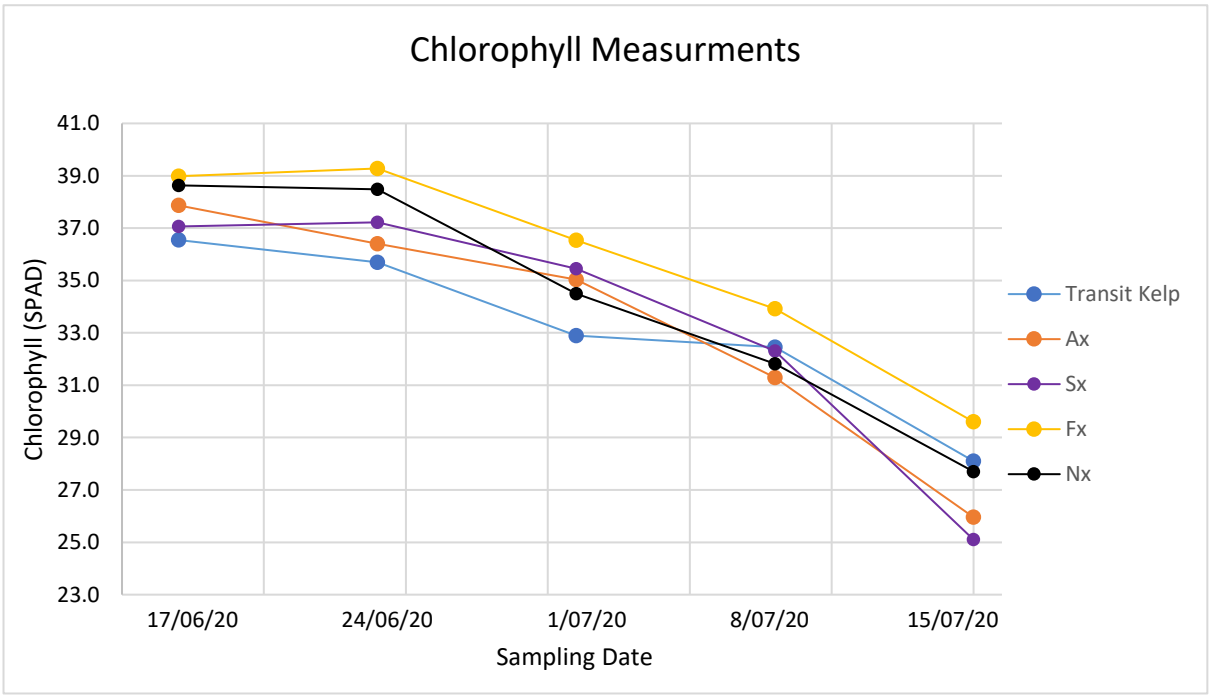

Figure 3: Average chlorophyll measurements of Soybeans treated with different types of kelp. Measurements were taken weekly and averaged. Other treatments besides Transit Kelp(R) cannot be displayed for legal reasons.

Table 2: Summary table showing the percentage increase in plant height from the first measurement (17/06/2020) to the last measurement (15/07/2020).

Treatment	Percentage Increase in Plant Height
Transit Kelp (A)	4.45%
Product B (Ax)	3.09%
Product C (Sx)	7.19%
Product D (Fx)	5.26%
Product E (Nx)	4.79%

Table 3: Summary table showing the percentage increase in plant chlorophyll levels from the first measurement (17/06/2020) to the last measurement (15/07/20).

Treatment	Percentage Decrease in Chlorophyll
Transit Kelp (A)	23.01%
Product B (Ax)	31.40%
Product C (Sx)	32.35%
Product D (Fx)	35.64%
Product E (Nx)	28.24%

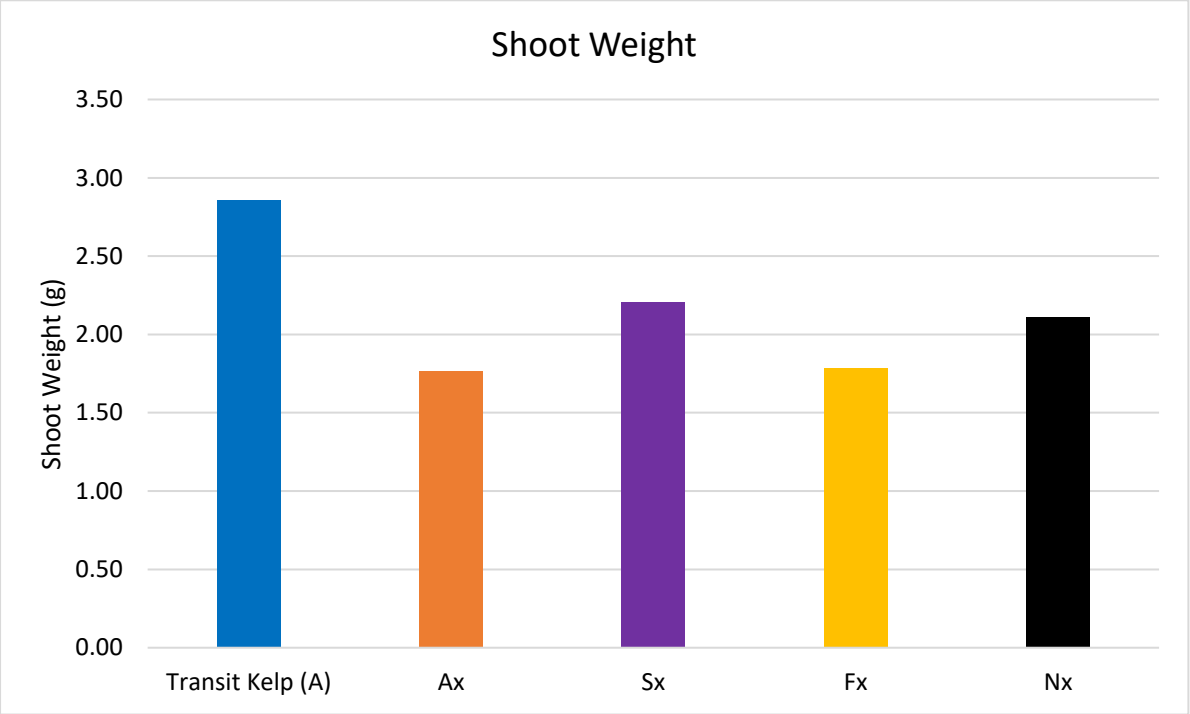

Figure 4: Average fresh shoot weight of soybeans treated with different types of kelp. These measurements were taken at the end of the experiment on the 15/07/2020.

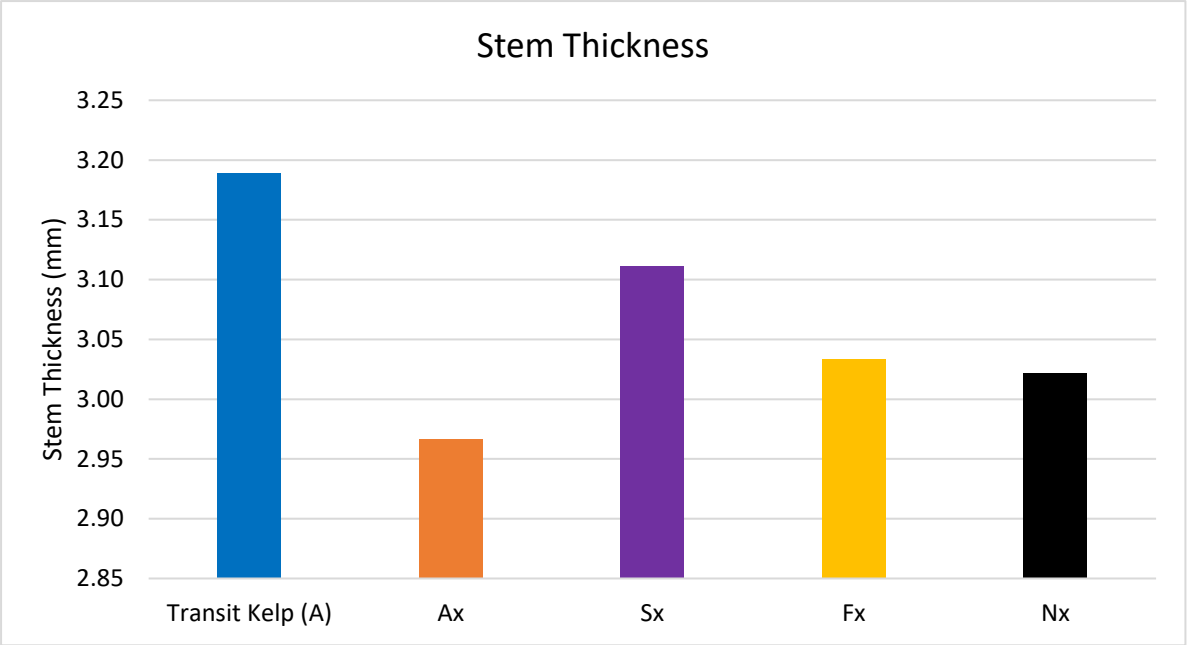

Figure 5: Average stem thickness (stem diameter) of soybeans treated with different types of kelp. These measurements were taken at the end of the experiment on the 15/07/2020.

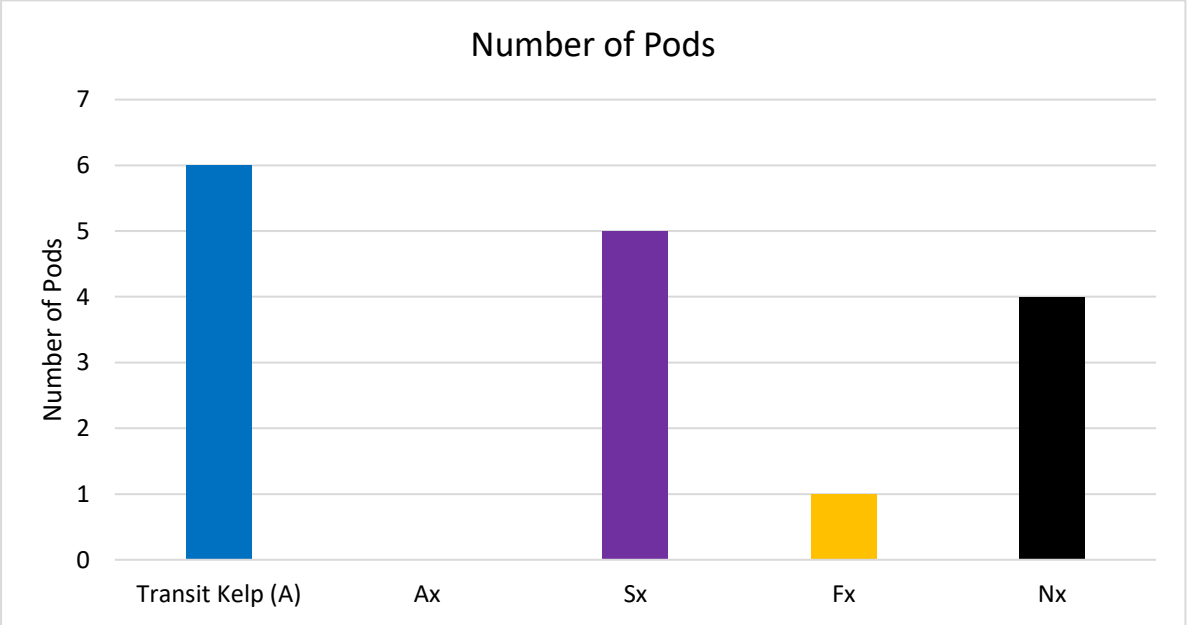

Figure 6: Total number of developed pods on soybeans treated with different types of kelp. These measurements were taken at the end of the experiment on the 15/07/2020

Figure 7: Images of each soybean treatment towards the end of the experiment. Product A - Transit Kelp(R), Product B - Ax, Product C - Sx, Product D - Fx, Product E - Nx

Discussion

When looking at figure 2, it can be seen that Transit Kelp® had the highest average plant height throughout the 1-month experiment with the final average plant height being approximately 18.7cm tall. This is significantly higher than the other kelp treatments. When looking at the percentage increase in height from the start of the experiment to the end of the experiment, it can be observed that Transit Kelp® treated Soybeans had a 4.45% increase in height. However, in terms of percentage increase in height, Transit Kelp® was ranked at 4th out of all the treatments which is seen in table 2. Sx treated performed the best with a percentage increase of 7.19%. From this, it can be concluded that Transit Kelp® induced an immediate response which significantly helped plant development at early stages in the germination of the Soybean seeds. However, the reason why there was not a significant increase in plant height is due to the type of kelp extract used. Each kelp product trial contains different varieties of kelp which therefore have difference compositions. These changes in compositions result in fluctuating levels of plant growth hormones such as Auxin and Cytokinin depending on the kelp species. Some kelp varieties are high in Auxin which means stem elongation and the inhibition of lateral buds will induced (Balzan, Johal and Carraro, 2014). Some are higher is Cytokinin (such as Transit Kelp®) which mainly assists in new cell growth and differentiation in root and shoots, but also affects apical dominance, axillary bud growth and leaf senescence (Akhtar, Mekureyaw, Pandey and Roitsch, 2020). Transit Kelp® is rich in the plant growth hormone Cytokinin, this may be the reason why there was a sharp increase in growth at the beginning of application as Cytokinin helps with new cell development and apical dominance which means the soybeans were concentrating growth on the main, central stem of the plant is dominant over other side stems.

Chlorophyll levels were compared to examine plant stress. Since none of the treatments received any other nutrient source besides the kelp, the plants experience nutrient deficiencies. However, one of the advantages of kelp is to assist with stress. Kelp also contains alginic acids and amino acids which all help with proper plant functions and metabolisms (Nabti, Jha and Hartmann, 2016). This means the plant has access to available amino acids and doesn't have to synthesize these amino acids themselves and expel energy. Transit Kelp® has approximately 2% amino acids and also have higher levels of nitrogen, phosphorous and potassium compared to other commercially available kelps. When looking at table 3, it can be seen that Transit Kelp® treated soybeans had the smallest percentage decrease in chlorophyll compared to all treatments. Transit Kelp® treated soybeans had a 23% decline in chlorophyll from the start of the month to the end of the month. When comparing this to the other treatments, this decline is much smaller meaning that the soybeans treated with Transit Kelp® were able to withhold their chlorophyll better than other treatments.

When looking at shoot weight shown in figure 4, it can be seen that Transit Kelp® had the highest shoot weight of 2.9g. when comparing this to the other treatments, Transit Kelp® treated shoots weighed significantly more than Ax and Fx. This is most likely due to more biomass in the leaves from less plant senescence due to better stress relief from nutrient stress. Also, because Transit Kelp® treated soybeans were also the tallest as seen in figure 2. Stem thickness was also highest in Transit Kelp® treated soybeans with an average stem diameter of 3.2mm seen in figure 5. This was not significantly higher than the other treatments.

Finally, when looking at figure 7 showing the comparative images of treated soybeans it can be seen that Transit Kelp® (labelled A) treated soybeans visually had larger leaves, taller steams and less leaf yellowing compared to the other treatments.

Conclusion

In conclusion, this trial was conducted to evaluate the benefits of Transit Kelp® against other commonly used commercial kelp fertilizer to assess shoot and leaf development. A number of different plant growth parameters were measured between each treatment to assess which treatment was the best at growing young soybeans plants with limited nutrition. The measurements taken was fresh shoot weight, shoot height, stem thickness, number of developed pods and average chlorophyll levels.

When studying the figures and tables presented above, it can be found that soybeans treated with Transit Kelp® had the following improvements compared to other commonly used commercial kelps in horticulture.

- Soybeans treated with Transit Kelp® were the tallest throughout the entire experiment with measurements being taken once a week.
- Transit Kelp® was the most effective at reduce nutrient stress in soybeans and maintain chlorophyll levels better with a reduction in chlorophyll at only 23% compared to other treatments which had a reduction of 30% and higher.
- Transit Kelp® treated soybeans had the heaviest shoots compared to all other treatments with an average shoot weight of 2.9g.
- Transit Kelp® treated soybeans also produced the thickest stem diameter of on average 3.2mm compared to other treatments.
- When looking at the comparative images of treated soybeans it can be seen that Transit Kelp® (labelled A) treated soybeans visually had larger leaves, taller stems and less leaf yellowing compared to the other treatments.

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