Enhancing Efficiency and Performance of MAP Granular Fertilizer through Coating with CPPA

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Abstract

Enhancing the efficiency of fertilizer is a crucial task in the agricultural industry in order to improve the crop performance. The aim of this study was to evaluate the effects of monoammonium phosphate (MAP) and CPPA-coated MAP on different growth parameters of corn plants. Plant height results indicated that both MAP and CPPA-coated MAP treated plants had highest plant height compared to the control. However, there was no significant difference was observed between MAP and CPPA-coated MAP treatments. Stem thickness measurements showed a slightly higher stem thickness in MAP-treated plants; however, it was not statistically significant. Leaf chlorophyll content was consistent across all treatments. Fresh weight analysis data indicated significantly higher weights in both MAP and CPPA-coated MAP treated plants compared to the control, with MAP-treated plants showing significantly higher vegetative weight. Root fresh weight assessment demonstrated significantly higher weight in CPPA-coated MAP treated plants compared to MAP-treated and control plants. Visual comparison of root architecture showed distinct differences between MAP and CPPA-coated MAP treatments, with CPPA-coated MAP showing enhanced root development. Plant dry matter analysis further supported these findings, revealing a significant increase in dry matter content in CPPA-coated MAP treated plants compared to MAP-treated plants and controls, emphasizing the efficacy of CPPA coating in improving plant growth and biomass accumulation, with an increment of 31.3%.

Keywords: *Zea mays*, CPPA, MAP, Coating, Crop performance, Root growth

1. Introduction

Improving the efficiency of granular fertilizer is an important task to enhance the efficiency of the fertilizers. Coating can be carried out by using bio stimulants to improve the characteristics of the granular fertilizer. It is well documented that the coating granular fertilizer with bio stimulants has increased the fertilizer efficacy as well as crop performances in different crops such as barley (Goñi, Łangowski, Feeney, Quille, & O'Connell, 2021), Valerianella locusta and Diplotaxis tenuifolia (Adamiano et al., 2021).

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Corn industry plays a crucial role in Agricultural food production in Australia which produces roughly 440,000 tonnes of corn per year. Among them most of the corn being used in the domestic market for livestock feed, corn flower and other industrial products (Daly, 2018). Maximizing economic return is one of the major challenges in corn production. In order to maximize yields and promote plant growth, bio-stimulants have been used in conjunction with traditional fertilizers. These plant bio-stimulants enhance natural processes in plants and soil which help boost crop quality and yield through enhancing water and nutrient uptake, improving nutrient efficiency and assist in mitigating stress (Quinn, 2021). Monoammonium phosphate (MAP) is a widely used fertilizer in corn cultivation, but there are some challenges associated with the nutrient loss and reduced efficacy. Coating MAP granules with CPPA (Complex Polymeric Polyhydroxy Acid) offers a promising solution to these challenges. CPPA is a group of organic acids which enhance various plant physiological functions such as nutrient absorption, shoot and root growth, germination and seedling emergence.

CPPA is currently provided by Dual Chelate Fertilizer under Patent. CPPA contains a mixture of naturally occurring organic substances which are found in composted plant materials. These substances are widespread in nature's soils, and fresh and saltwater environments of decaying plant materials. Contains natural acids with tannins, growth regulators, stimulators and auxins, which can be well suited for use in any seed, bulb, or rooted plant known to mankind. This research aims to investigate the effects of CPPA coating on MAP fertilizer on improving fertilizer efficiency and crop performance in corn. This study contributes to sustainable fertilizer management strategies. This study is a greenhouse pot trial and for upcoming advancements, it is planned to be executed directly in the field.

2. Objectives

The specific objectives of this study are to:

- Measure and compare the plant growth and development in three different treatments
- Compare the effectiveness of each treatment on root architecture
- Analysis of dry matter content in corn plants
- Compare the nutritional status of plant tissues

3. Materials and Methods

Site selection and Trial Design

The experiment took place in a greenhouse located in Robinvale, Victoria, Australia. It employed a randomized complete block design (RCBD) with four replicates to enhance the reliability and account for variability. Treatments were applied two weeks following seed germination.

MAP fertilizer was coated with a 0.5% CPPA solution and 5 grams of MAP and CPPA coated MAP were applied to each pot. Table 1 shows the treatments and application rates of each product.

Table 1: Treatments and application rates

Treatment	Rate (L/ha)
Control	No treatment
MAP	5g/pot
MAP + CPPA	5g/pot + 0.5% CPPA

4.Observations

Plant Height and Stem Thickness

After one month of the treatment application and at the harvesting time, plant height and stem thickness were measured by using a ruler and a Vernier Calliper respectively.

Chlorophyll (SPAD values)

Chlorophylls were checked 4 weeks after the treatment application. 5 leaves from each plant were measured using the SPAD chlorophyll meter to check the greenness of each leaf.

Fresh vegetative weight and root weight

At the harvesting time, plants were pulled out from pots and vegetative fresh weight and root weight were recorded.

Root Architecture

During the harvesting time, plants were removed from pots and the soil was washed away to carefully separate the root systems without causing any damage. Then, photographs were taken to compare the root systems.

Dry Matter%

At the harvesting time, plants were pulled out from pots and sent to the Agrifood for the dry matter analysis in corn plants.

Leaf Nutrient Analysis

Leaf samples were collected at harvesting time and sent to an independent laboratory called Analytical Laboratories & Technical Services Australia (ALTSA) for a full tissue nutrient profile analysis.

Data Analysis

A statistical analysis was done using Prism (Graph Pad Software). Significant difference ($P<0.15$) between the treatments was determined by comparing the replicate means. Graphs with error bars were also created using Prism.

5. Results

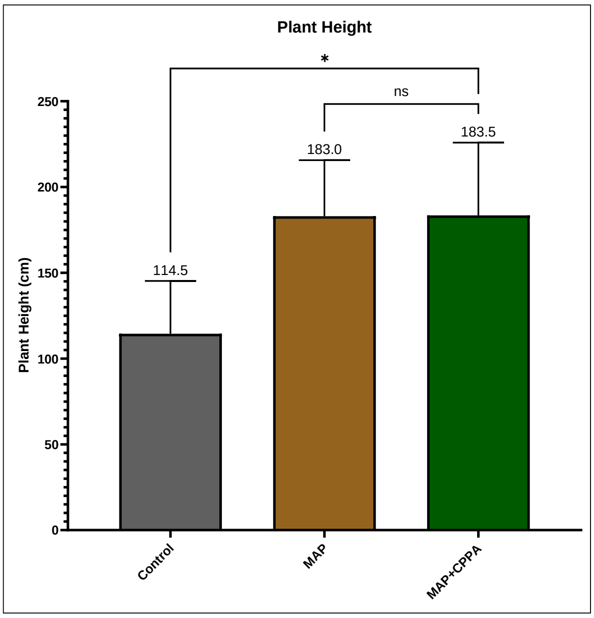

*Figure 1 Comparison of plant height in three treatments. Asterisks denote significant differences between treatments (*p < 0.05).*

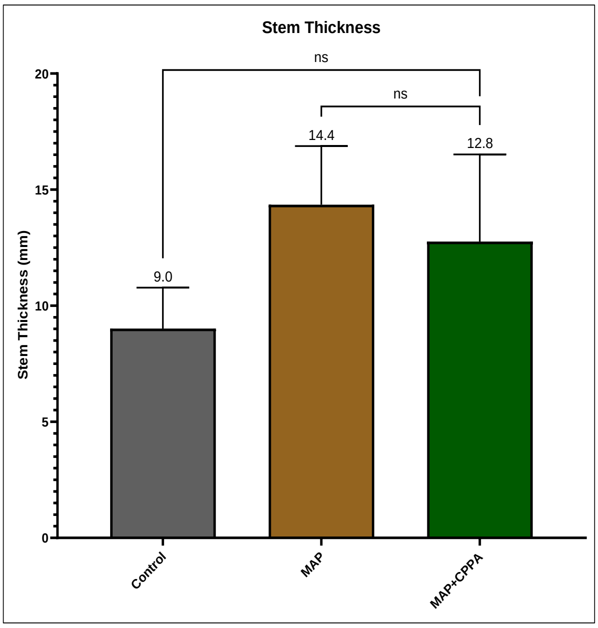

*Figure 2 Comparison of stem thickness in three treatments. Asterisks denote significant differences between treatments (*p < 0.05).*

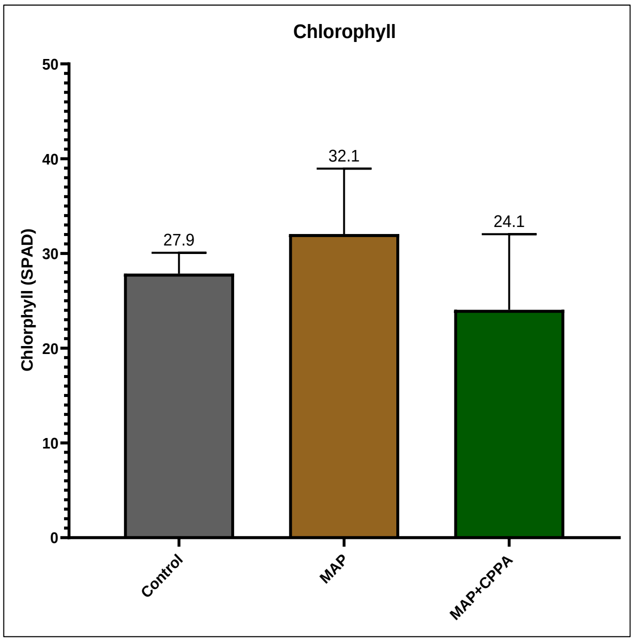

*Figure 3 Comparison of leaf chlorophyll in three treatments. Asterisks denote significant differences between treatments (*p < 0.05).*

Figure 4 Comparison of root architecture in control and CPPA coated MAP treated corn plants

Figure 5 Comparison of root architecture in CPPA coated MAP and MAP treated corn plants. (a) MAP + CPPA (b) MAP

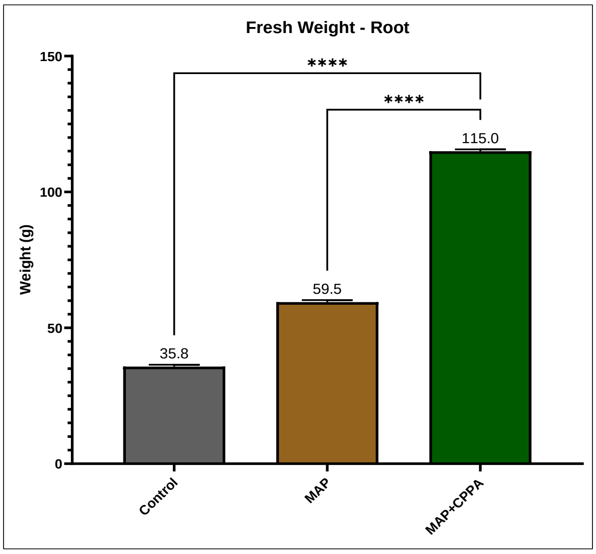

*Figure 6 Comparison fresh root weight of plants in three treatments. Asterisks denote significant differences between treatments (*p < 0.05).*

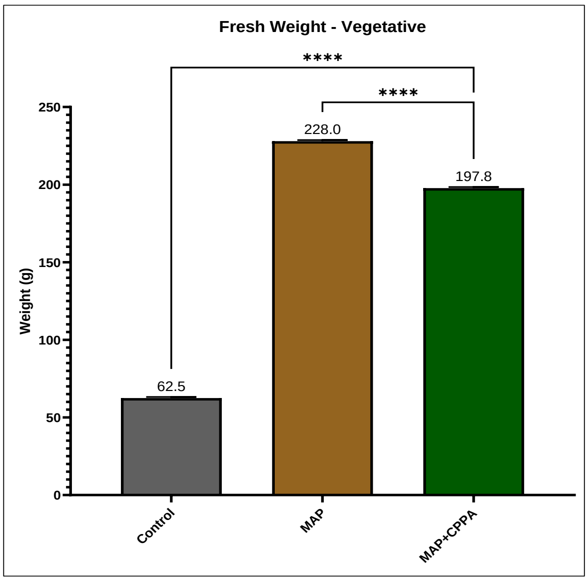

*Figure 7 Comparison of vegetative weight of plants in three treatments. Asterisks denote significant differences between treatments (*p < 0.05).*

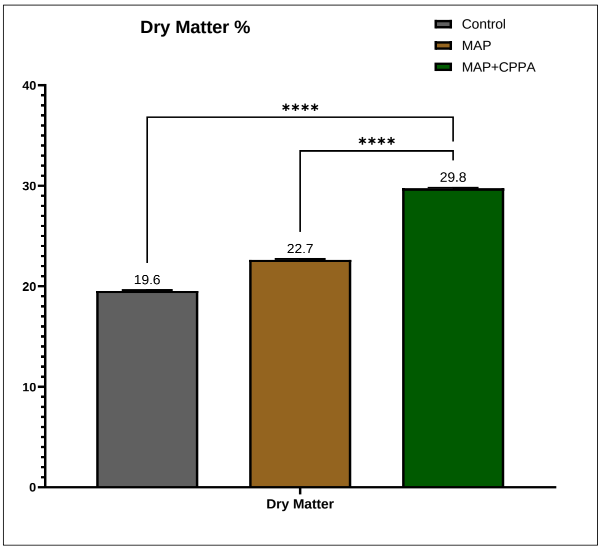

*Figure 8 Comparison dry matter percentage in three treatments. Asterisks denote significant differences between treatments (*p < 0.05).*

6. Discussion

Plant height data revealed that MAP and CPPA coated MAP applied plants had significantly higher plant height compared to the control. However, there was no significant difference was observed between MAP and CPPA coated MAP (Figure 1). Plant stem thickness was measured concurrently, it revealing that MAP exhibited a slightly greater thickness compared to all other treatments. However, this difference was not statistically significant (Figure 2). Leaf chlorophyll data was recorded to check the greenness of the leaves in each treatment. There was no significant difference was observed between treatments (Figure 3).

Fresh weight of the plant vegetative parts was measured and the results revealed that MAP and CPPA coated MAP had significantly higher fresh weight compared to the control. In addition, MAP had the significantly higher vegetative weight compared to the CPPA coated MAP (Figure 7).

In Figure 4 and 5, the root architecture of corn plants treated with both MAP and CPPA-coated MAP is visually compared, revealing distinct differences in root development between the two groups. Furthermore, Figure 7 illustrates a root comparison between untreated (control) plants and those subjected to the treatments. Plant dry matter analysis further supports these observations, indicating a significant increase in dry matter content in plants treated with CPPA-coated MAP compared to both the control group and those treated solely with MAP (as depicted in Figure 6). Remarkably, the dry matter content in CPPA coated MAP treated plants surpassed that of MAP treated plants by an impressive 31.3%, highlighting the enhanced efficacy of CPPA coating in promoting plant growth and biomass accumulation (Figure 8).

CPPA, which stands for Complex Polymeric Polyhydroxy Acid, is a group of organic acids known to enhance various plant physiological functions, including nutrient absorption, shoot growth, and root growth. Therefore, it can be inferred that the observed improvements in shoot and root growth are likely due to the impact of CPPA on enhancing these plant functions. Overall, the study suggests that the coating MAP with CPPA can be beneficial for promoting shoot and root growth in corn plants, potentially leading to increased overall plant biomass and productivity.

7. Conclusion

In conclusion, the application of both Monoammonium phosphate (MAP) and CPPA-coated MAP significantly influenced various growth parameters of corn plants compared to untreated control plants. Both MAP and CPPA-coated MAP treatments resulted in significantly taller plants compared to the control, indicating a positive effect on overall plant height. However, there was no significant difference observed in plant height between MAP and CPPA-coated MAP treatments. Root mass analysis demonstrated a significant increase in root fresh weight in plants treated with CPPA-coated MAP compared to both MAP-treated and control plants. This was further supported by visual comparisons of root architecture, showing distinct differences in root development between MAP and CPPA-coated MAP treatments.

Most significantly, plant dry matter analysis revealed a substantial increase in dry matter content in plants treated with CPPA-coated MAP compared to both the control and MAP-treated plants. This enhancement in dry matter content highlights the superior efficacy of CPPA coating in promoting plant growth and biomass accumulation, with a remarkable 31.3% increment compared to MAP-treated plants.

Overall, these findings suggest that CPPA-coated MAP offers promising benefits for corn plant growth and development, particularly in promoting root growth and enhancing overall biomass accumulation. Further research could delve into the underlying mechanisms driving these observed effects and explore the potential long-term impacts on crop productivity and sustainability.

8. References

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