Improving the Efficacy of NPK Fertilizer through Coating with CPPA

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Abstract

Enhancing the fertilizer use efficiency is crucial for optimizing crop productivity in the agriculture industry. This study evaluates the effectiveness coating CPPA on improving the efficacy of NPK granular fertilizer as well as enhance the crop productivity. The results revealed that, CPPA-coated commercial NPK fertilizer (Cx) enhanced the growth parameters and yield attributes of wheat. CPPA coated Cx improved the wheat seed germination in early stages. In addition, CPPA coated commercial fertilizer significantly improve the plant height, leaf chlorophyll levels, and the number of heads per plant. Moreover, CPPA coated Cx showed superior effects on both plant and soil nutritional status compared to all other treatments. These findings showed the impact of CPPA-coated NPK fertilizer on enhancing crop growth and development as well as improve soil and plant nutritional status. Therefore, coating NPK granular fertilizer with CPPA is beneficial in improving crop growth and development as well as improving soil and plant nutritional status.

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 efficacy 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).

Wheat plays a crucial role in Australian Agriculture sector. There are different factors that caused to constraint the wheat yield such as pest and disease, fertilizer usage, land degradation etc. Improving fertilizer usage efficiency is a better solution to improve the yield and yield quality while maintaining the environmental sustainability.

Maximizing economic return is one of the major challenges in crop 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).

Coating NPK granular fertilizer 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 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 NPK fertilizer on improving fertilizer efficiency and crop performance in wheat. 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 improving grain yield
- Compare the nutritional status of plant tissues and soil

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 at planting.

Commercial NPK granular fertilizer was coated with a 1% CPPA solution and 5 grams of CPPA coated fertilizer was applied in to each pot. Five grams of commercial fertilizer and Complete Blue Diamond fertilizer was applied itself to each pot without coating with CPPA. 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
Cx (Commercial NPK fertilizer)	5g/pot
Cx+ CPPA	5g/pot + 1% CPPA
Blue Diamond	5g/pot

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

Number of Heads

During the harvesting time, number of heads per plant was counted to get an approximation about the wheat yield.

Leaf and Soil Nutrient Analysis

Soil and Leaf samples were collected at harvesting time and sent to an independent laboratory called Analytical Laboratories & Technical Services Australia (ALTSA) for a full soil and 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

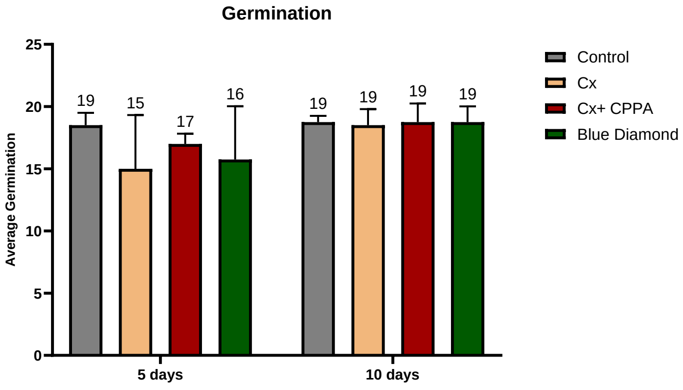

Figure 1 Compare the wheat germination in four different treatments after 5 days and 10 days of planting.

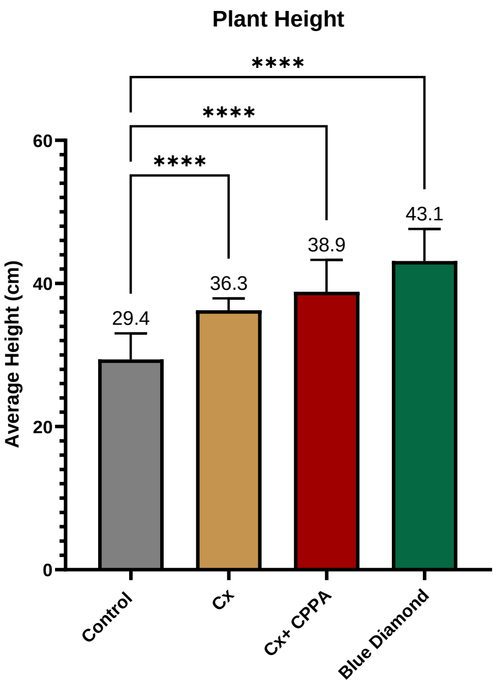

Figure 2 Comparison of plant height in four different treatments after 6 weeks of planting. Significant difference between treatments (P<0.05)

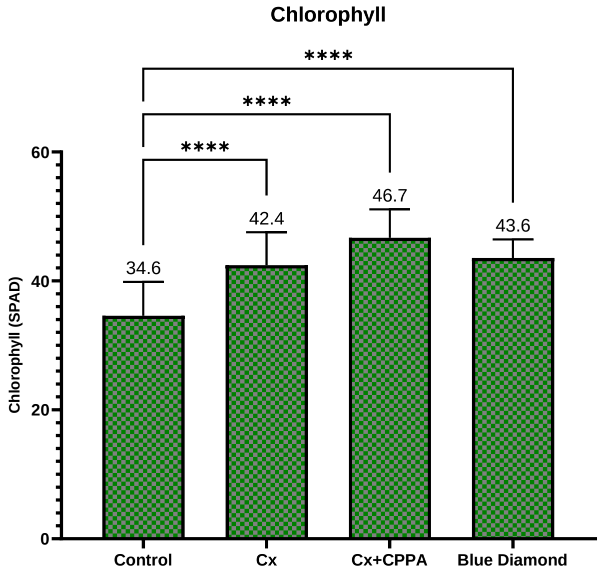

Figure 3 Effectiveness of each treatment on improving leaf chlorophyll levels. Significant difference between treatments (P<0.05

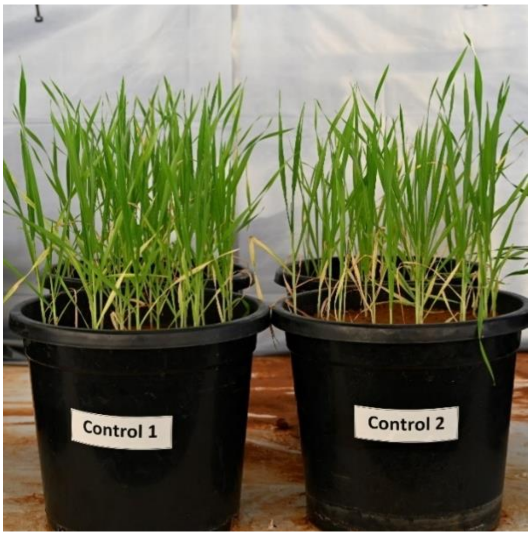

Figure 4 Visual comparison of plant growth in four different treatments after 6 weeks of the treatment application

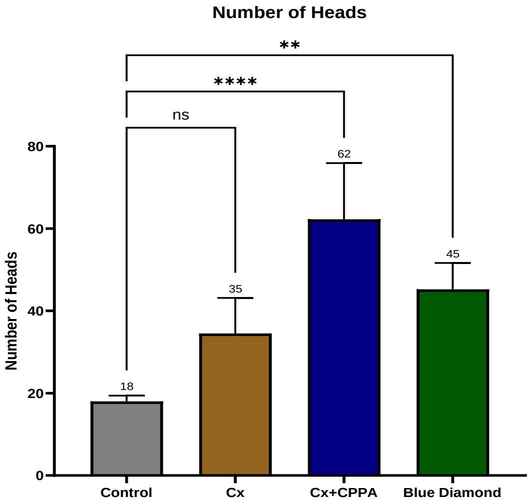

Figure 3 Compare the effectiveness of coating NPK granular fertilizer with CPPA on improving number of heats per plant. Significant difference between treatments (P<0.05)

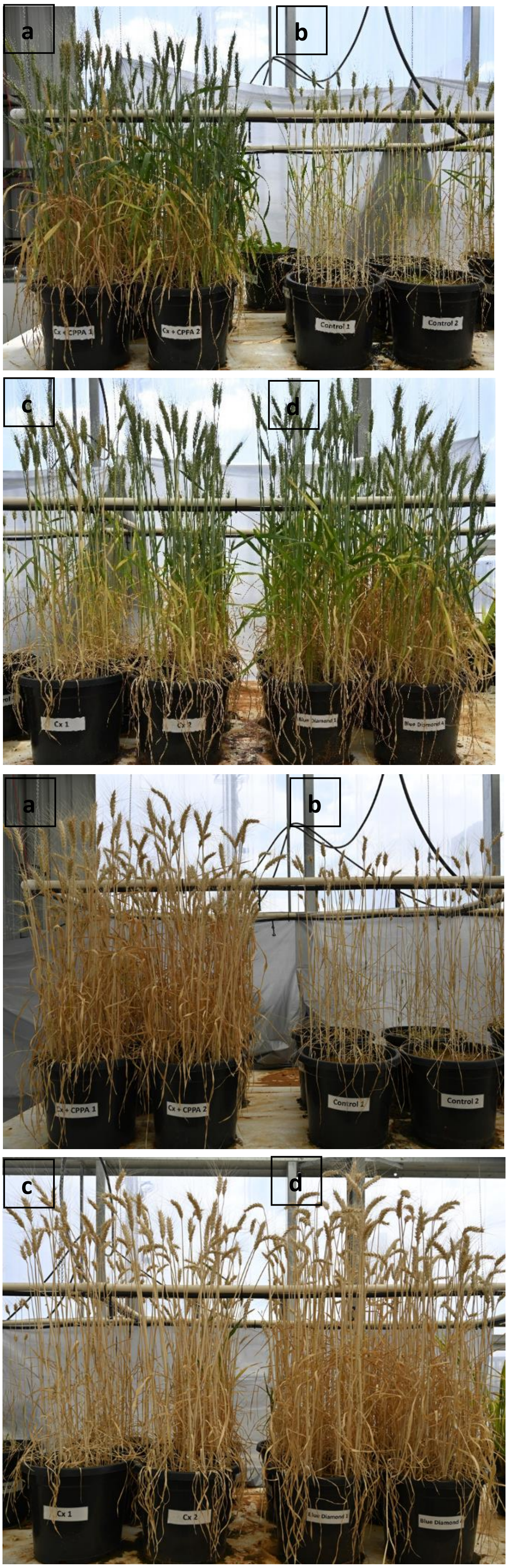

Figure 6 Visual comparison of crop growth and development at different growth stages

Table 2 Comparison of leaf nutrients including macronutrients, micronutrients and other elements in each treatment after three

	Nutrient	Unit	Cx	Cx + CPPA	Blue Diamond
Macronutrients	Total Nitrogen	%w/w	3.6	4.5	3.8
	TD-Phosphorus (P)	%w/w	0.429	0.536	0.512
	TD-Potassium (K)	%w/w	2.47	2.7	2.46
	TD-Sulphur (S)	%w/w	0.282	0.433	0.256
	TD-Calcium (Ca)	%w/w	0.486	0.691	0.397
	TD-Magnesium (Mg)	%w/w	0.175	0.279	0.185
Micronutrients	TD-Boron (B)	mg/kg	73.5	73.3	51.8
	TD-Copper (Cu)	mg/kg	9.9	21.2	9.9
	TD-Iron (Fe)	mg/kg	75	120	75.4
	TD-Molybdenum (Mo)	mg/kg	<0.5	<0.5	<0.5
	TD-Manganese (Mn)	mg/kg	36.6	61.8	41.1
	TD-Zinc (Zn)	mg/kg	16	29.9	14
	Chloride (Cl)	%w/w	1.68	1.77	1.62
Other	TD-Aluminium (Al)	mg/kg	<100	<100	<100
	TD-Cobalt (Co)	mg/kg	<0.5	<0.5	<0.5
	TD-Nickel (Ni)	mg/kg	2.1	2.6	2.2
	TD-Silicon (Si)	mg/kg	170	290	300
	Nitrate Nitrogen	mgN/kg	<50	823	<50
	Total Carbon	%w/w	43	44	45
	TD-Sodium (Na)	%w/w	<0.01	0.02	<0.01

Table 3 Comparison of soil nutritional status at post-harvest time

	Control	Blue Diamond	Cx	Cx+ CPPA
Total Nitrogen	<0.05	<0.05	<0.05	<0.05
RA-Phosphorus (P)	1.6	12.5	9.3	12
RA-Potassium (K)	3.9	11.5	10.6	22.6
RA-Calcium (Ca)	25.3	28.8	26.4	27.7
RA-Magnesium (Mg)	5.7	6.8	4.5	4.9
RA-Boron (B)	0.2	0.1	0.2	0.4
RA-Copper (Cu)	<0.1	<0.1	<0.1	<0.1
RA-Iron (Fe)	<0.1	<0.1	<0.1	<0.1
RA-Manganese (Mn)	<0.1	<0.1	<0.1	<0.1
RA-Molybdenum (Mo)	<0.1	<0.1	<0.1	<0.1
RA-Zinc (Zn)	<0.1	<0.1	<0.1	<0.1
RA-Aluminium (Al)	<1	<1	<1	<1
RA-Sodium (Na)	15.5	19.8	24.2	17
RA-Silicon (Si)	4.4	3	3.5	4
RA-Sulphur (S)	3	2.4	6.9	9.8

6. Discussion

Wheat germination was recorded from the 3rd day from planting up to 12 days. Germination data revealed that the control and CPPA coated commercial fertilizer (Cx) had highest germination count by day 5 compared to the other treatments. However, by day 10, all four treatments had approximately similar germination (Figure 1). Plant height was recorded after 6 weeks of planting to assess the effectiveness of each treatment on improving plant growth. Blue Diamond had significantly highest plant height compared to all other treatments. In addition, Cx and CPPA coated Cx had significantly higher plant height compared to the control. Moreover, pots treated with CPPA coated Cx had highest plant height compared to the pots that treated with Cx itself (Figure 2). At the same time, leaf chlorophyll status was recorded by using SPAD Chlorophyll meter to compare the effectiveness of each treatment on improving leaf chlorophyll. The results indicated that CPPA coated Cx significantly improved the leaf chlorophyll levels compared to all other treatments (figure 3).

Photos were taken during different crop growth stages to visually compare the crop growth in each treatment. Figure 4 shows the visual comparison of crop growth after 6 weeks of planting. These photos showed that CPPA coated Cx had visually better crop growth than other treatments. During the harvesting time, number of heads per each plant was counted to get a yield estimation. According to the data, CPPA coated Cx had the significantly higher head counts compared to all other treatments (Figure 5). Figure 6 shows the visual comparison of plant growth at different crop growth stages.

Plant tissue analysis was done after 3 months of planting to check the plant nutritional status in each treatment. By the sample collection time, control hadn't enough plant growth to collect leaf samples. The results showed that CPPA coated Cx had highest amount of leaf nutrients compared to all other treatments. In addition to the tissue testing, soil samples were taken at the post-harvest time to check the soil nutritional status in each treatment. The results revealed that CPPA coated Cx had highest levels of Potassium, Calcium, Magnesium, Boron and Sulphur compared to all other treatments including the Cx itself. Therefore, coating NPK granular fertilizer with CPPA is greatly improved the nutritional status in plants and soil including macro and micronutrients. Similar to these results, numerous studies have found that coating granular fertilizer with bio stimulants is beneficial in improving plant growth and development as well as improving crop yield (Gil-Ortiz et al., 2020, Guelfi et al., 2022).

7. Conclusion

In this study, commercial NPK granular fertilizer was coated with CPPA to improve the efficacy of fertilizers. CPPA coated Cx greatly improved the seed germination at early stages. It significantly improved the plant height, leaf chlorophyll levels, number of heads per plant. In addition, CPPA coated Cx improved the plant and soil nutritional status compared to all other treatments. In conclusion, coating NPK granular fertilizer with CPPA is beneficial in improving crop growth and development as well as improving soil and plant nutritional status.

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