Assess the Effectiveness of Zinc Fertilizers and Organic Activators on Wheat Germination and Early Seedling Growth

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Abstract

Wheat plays a crucial role in Australian grain production. Different internal and external factors affect seed germination and seedling growth. Nutrients play a crucial role in seed germination and seedling growth and development. This trial was conducted to analyze the impact of some Zinc fertilizers and organic activators on improving seed germination and seedling growth in early stages. It was found that wheat seeds treated with Transit Zn and CPPA had a significant increment in shoot length compared to the control. Also, Transit Zn, CPPA, Amino Boost Transit Max, and Momentum ZnP treated seedlings had significantly highest root lengths than seedlings collected from other treatments. So, it can be concluded that Transit Zn and CPPA are excellent products for wheat seedling growth and development. Also, Amino Boost Transit Max and Momentum ZnP are other good options for wheat growth and development in the early stages. However, there was no significant difference found between treatments in seed germination, and all treatments performed well. Therefore, it can be recommended that the application of Transit Zn and CPPA as a seed treatment for Wheat is beneficial in terms of seed germination and seedling growth.

Keywords: Wheat, Germination, Seedling growth, Root growth, Zinc Fertilizers, Organic Activators

1. Introduction

The grain industry is the Australian second largest agricultural industry which contributes 27% of the gross value of production (Our industry, 2022). Wheat is an important cereal crop in the world. Australian Wheat industry is accountable for 12% of the world's wheat export (ABARES, 2012). Seed germination is a fundamental process which affected by different external or environmental factors such as temperature, pH, and soil moisture and external factors as well as internal factors such as phytohormones, nutrients, etc. In addition, seed germination is regulated by different genes (Koger, Reddy, & Poston, 2004, Xue et al., 2021). Macro and micronutrients play a crucial role in seed germination, plant growth, and development. Zinc and phosphorous are the key nutrients for better crop growth and yield (Arshad *et al*. 2016). Phosphorus and Zinc are readily absorbed leaves allowing rapid uptake and optimizing Zn and P levels at crucial early growth stages before soil-applied P is available. Moreover, Adequate delivery of Zinc & Phosphorus increases the production of energy molecules, and plant growth hormones and facilitates photosynthesis and nutrient transport.

Zinc is a critical element for better and more vigorous wheat growth. It is both an activator and component of many enzymes and also influences auxin development (plant growth hormone) which promotes strong crop growth. Numerous studies have demonstrated that Zinc is responsible for a higher and a quality wheat yield (Arshad *et al*. 2016). It is well documented that the Zinc content in seeds is highly affected by seed germination and seedling vigor in different broadacre crops such as wheat and barley (Imran, Mahmood, Neumann, & Bolt, 2021). Also, wheat seeds with high Zinc content can develop more shoots and roots at the early seedling stages and facilitates the uptake of more Zn in Zn-deficient soil (Graham & Rengel, 1993). Numerous studies have proven the impact of Zn seed treatment on seed germination, seedling growth, and yield. Harris, Rashid, Miraj, Arif, & Shah revealed that the seed treatment with 1% Zinc Sulphate improved the plant growth and yield in maize grown in Zn deficiency soil.

Dual Chelate Fertilizer Pty Ltd has developed a premium quality Zn fertilizer product called Momentum ZnP, Momentum ZBM Trio, Transit Zn as well as some other organic activators such as Transit Re-Leaf, Amino Boost Transit Max, and CPPA. Amino Boost Transit Max assists in increasing root growth, improving the translocation of nutrients, and enhancing the establishment of young plants. Amino Boost Transit Max® (ABTM) contains 10% Amino Acids, 6%, Kelp, 4% Fulvic Acids, 1.5% organic activators, and 1.4% Nitrogen (Amino Acid derived Nitrogen). Momentum ZnP is a plant-available liquid Zinc & Phosphorus fertilizer designed to provide plants with optimal nutrients to promote early crop growth and establishment. Momentum ZnP consists of 18% Phosphorous, 14% Zinc, 2% Potassium, and patented organic activators. CPPA (Complex Polymeric Polyhydroxy Acid) is a group of organic acids that enhance various plant physiological functions such as nutrient absorption, shoot, and root growth. In this study, wheat seeds were treated with a 10% solution of each fertilizer product and organic activators to study the effectiveness of each product on seed germination and seedling growth.

2. Objectives

The specific objectives of this trial were to:

- Study the impact of treatments for seed germination.
- Measure the Shoot length and root length in each treatment
- Assess the impact of different fertilizer products for seedling growth and development.
- Visually compare the treatments to see any difference in appearance.
- Compare the benefits of treatments for wheat seed germination and seedling growth.

3. Materials and Methods

This trial was conducted in the greenhouse located at Robinvale. There were 8 treatments and 4 replicates in this trial. Razor wheat variety was selected for this trial and seeds were treated with 10% solution of each fertilizer product. Seeds were then placed in Petri dishes and each petri dish had 10 seeds. Petri dishes were misted, covered with lids, and then placed in a dark area. Germination count was recorded daily starting from day 3. Seedling measurements were taken after 12 days of treatment application.

Figure 1: Wheat seeds; variety Razor

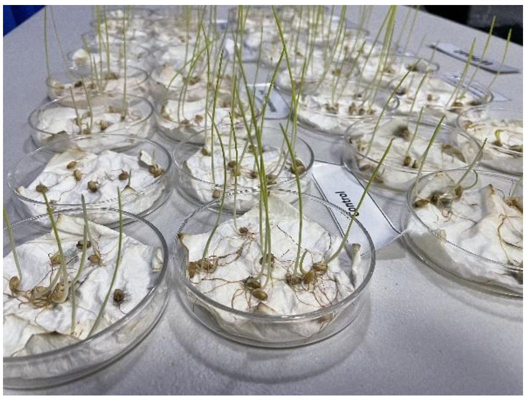


Figure 2: Wheat seedlings in day 12

Table 1: Application rates and product analysis of Zinc fertilizers and other organic activators.

Treatment	Rate	Product Analysis
Control	N/A	N/A
Amino Boost Transit Max	10%	10% Amino Acids, 6% Kelp, 4% Fulvic Acids, 1.5% Organic activators, 1.4% N
Momentum ZnP	10%	18.10% P, 2% K, 14% Zn
Momentum ZnP with Amino Acid and CPPA	10%	18.10% P, 2% K, 14% Zn + Amino Acid + CPPA
Momentum ZBM Trio	10%	5.30% B, 5.01% Zn, 0.24% Mo, 0.15% Mg + Amino acids
Transit Re-Leaf	10%	Fulvic acids, Amino acids, CPPA
Transit Zn	10%	3.67% N, 10.40% Zn, CPPA + Amino acids
CPPA	10%	Patented Organic

4. Observations

Germination Count

From day 3 onwards, the germination count was recorded daily and comparative photos were taken to visualize the impact of Zn products and organic activators on seed germination.

Shoot Height

After 12 days of seed sowing, seedlings were uprooted carefully, and measured the shoot height by using a ruler.

Root Length

After 12 days of seed sowing, seedlings were uprooted carefully, and measured the root length by using a ruler.

Comparative Photos

Comparative photos were taken to visually compare the seedling growth and root development.

5. Results

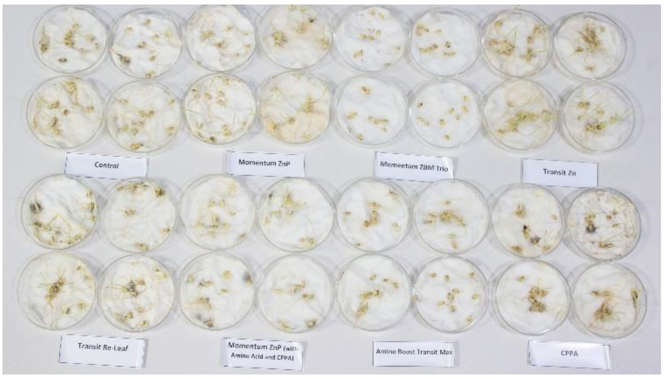


Figure 3: Visual comparison of seed germination in different treatments in day 4

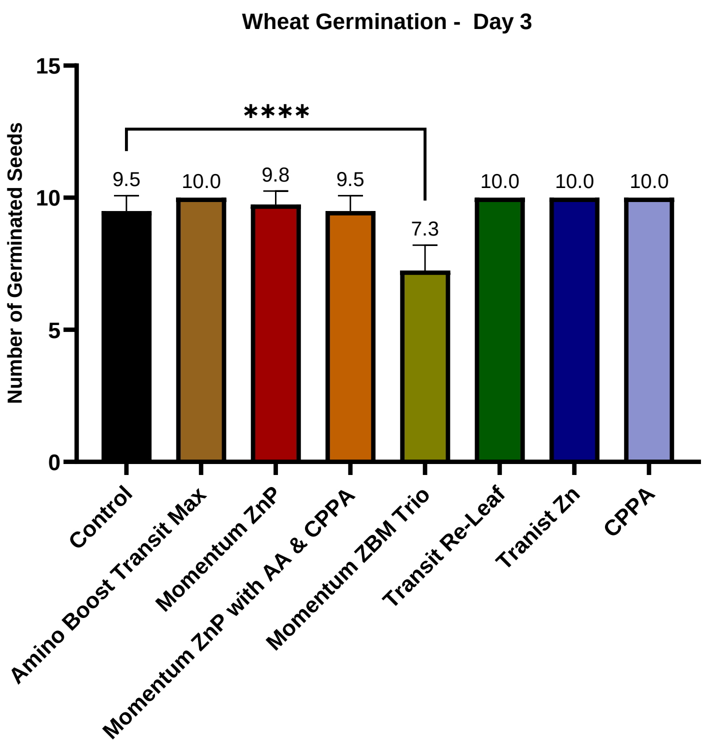


Figure 4: Effects of different Zn fertilizer products and organic activators on wheat seed germination in day 3. Asterisks represent statistical significance (** p,0.0001).**

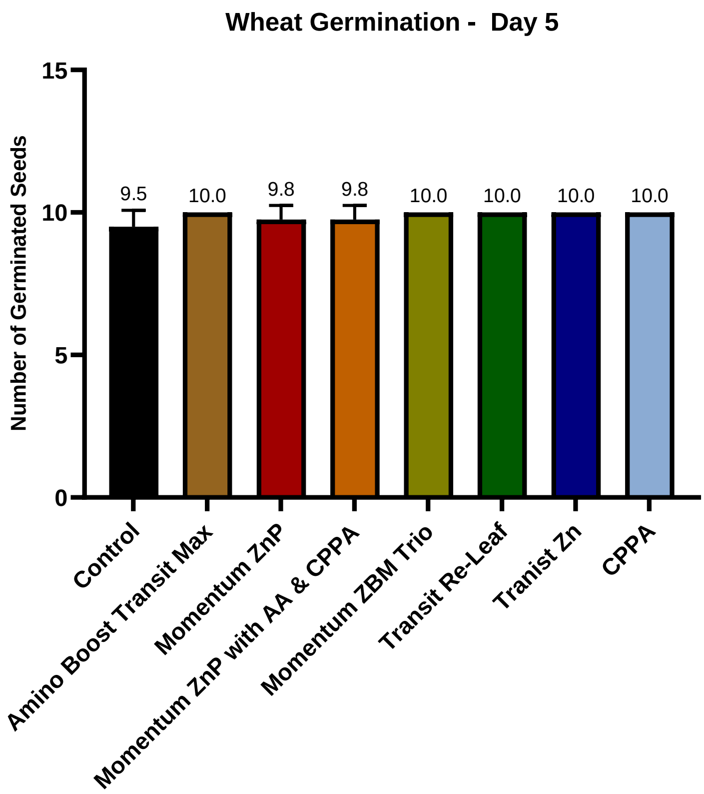
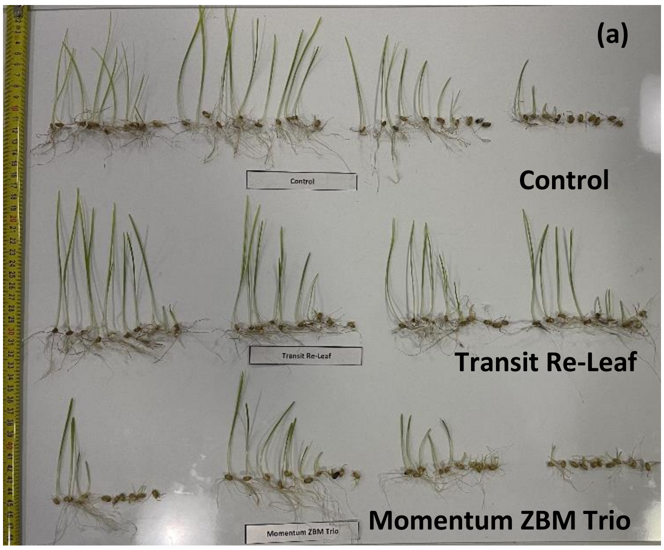
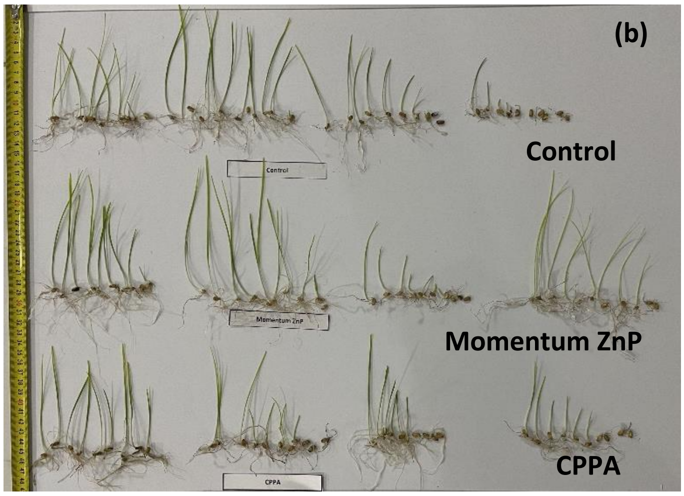


Figure 5: Effects of different Zn fertilizer products and organic activators on Wheat seed germination in day 5. Asterisks represent statistical significance (** p,0.0001).**





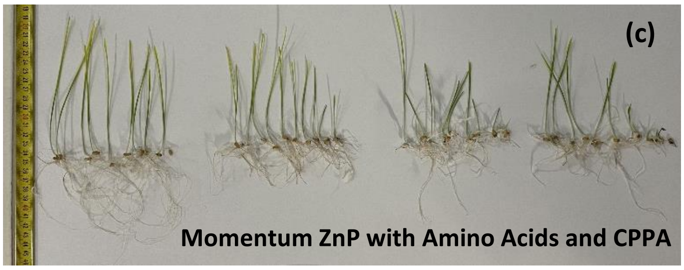


Figure 9: Visual comparison of wheat seedling shoot and root growth in different treatments (a-e) in day 12.

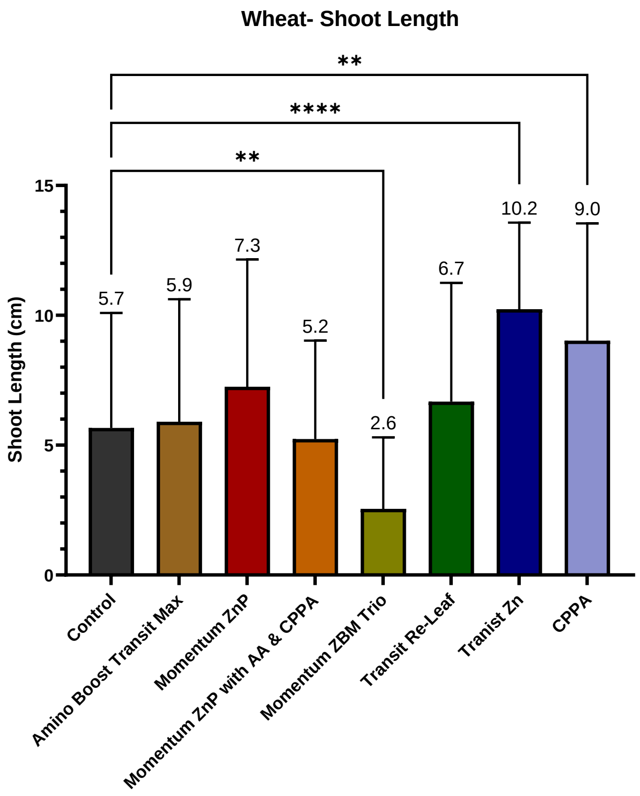


Figure 7: Effects of different Zn fertilizer products and organic activators on wheat shoot length. Asterisks represent statistical significance (** p,0.0001).**

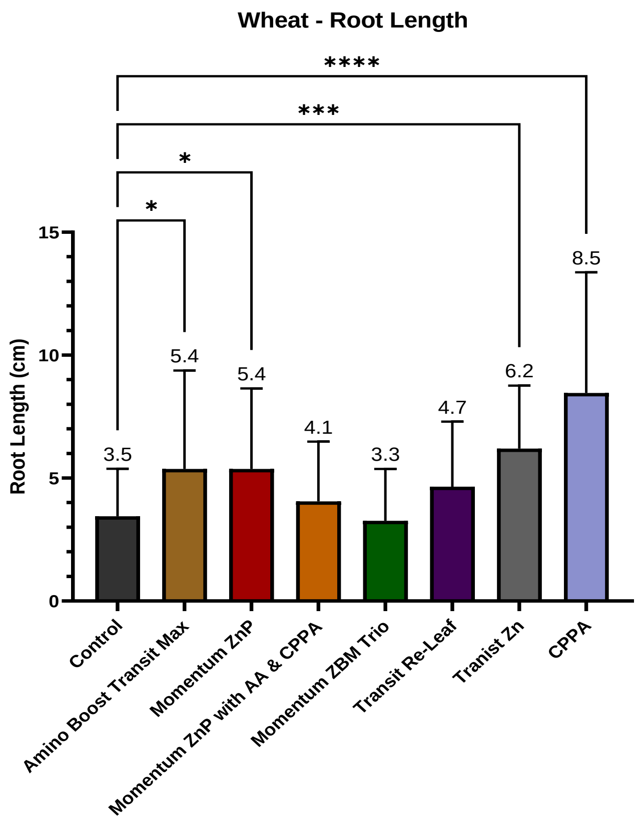


Figure 8: Effects of different Zn fertilizer products and organic activators on wheat root length. Asterisks represent statistical significance (p,0.01).**

6. Discussion

Germination data were collected from day 3 of the seed sowing. Amino Boost Transit Max, Transit Re-Leaf, Transit Zn, and CPPA had a 100% germination rate on day 3 whereas all other treatments had average germination between 9-10 except Momentum ZBM trio (Figure 4). By day 5, all treatments have reached an average of around 10 (Figure 5). Hence, there are no significant differences in seed germination between treatments.

After 12 days of seed sowing, seedlings were uprooted, and measured the shoot height and root length. Transit Zn and CPPA had the significantly highest shoot length compared to all other treatments. Furthermore, Transit Zn also showed a higher shoot length, however, that was not a significant difference (Figure 7). After 12 days, Amino Boost Transit Max, Momentum ZnP, Transit Zn, and CPPA resulted in significantly the highest root length compared to the control (Figure 8). Furthermore, all other treatments except Momentum ZBM Trio had the highest root length than the control seedlings (Figure 8). These results can be explained by the role of Zinc in seed germination and photosynthesis (OHKI, 1976). Zinc seed treatments have a great impact on improving seed germination, seedling growth, and development (Montanha et al., 2020). Prom-u-thai, Rerkasem, Yazici, & Cakmak found that seed priming with Zinc has a great influence on improving seed germination, root development, and dry weight in rice.

It was found that there is a great impact of Zinc, Phosphorous, Amino acids, and CPPA on seed germination as well as plant growth and development. Zinc is a crucial micronutrient for better and vigorous wheat growth. It is both an activator and component of many enzymes and also influences auxin development (plant growth hormone) which promotes strong crop growth (Begum et al., 2016). Numerous studies have demonstrated that Zinc is responsible for a higher and a quality wheat yield (Arshad et al. 2016). Similarly, Auxin promotes stem elongation and guides shoot tips toward light sources which is a movement known as phototropism. Auxin also plays a role in maintaining

apical dominance which explains the significant increment in plant growth parameters between the treatments and the control.
Furthermore, the application of Phosphorous is greatly influenced by the yield maximizing in wheat (Grant and Baile, 1989). Phosphorous is the key nutrient for better root and shoot growth, especially in the early stages (Boring et al., 2018). Moreover, Phosphorus is incorporated into many organic compounds such as DNA, proteins, lipids, and enzymes. These organic compounds assist in energy transfer, nutrient uptake, and transport. A slow-release form of phosphorus allows for better nutrient utilization and absorption during the season (Talboys et al., 2015). Therefore, the increment of plant growth parameters in treated wheat plants should be due to the role of Phosphorous and Zinc. In addition, Zinc and Phosphorous have a great impact on plant root growth and several studies have demonstrated the importance of these nutrients on root growth in different plants such as Zea mays L. and rice (Hajabbasi and Schumacher, 1994, Phuphong et al., 2020). Therefore, this difference should be due to the influence of Zinc on seed germination and photosynthesis (OHKI, 1976).

Amino acids play a crucial role in plant growth and development. There are numerous studies have been conducted to assess the importance of amino acids on plant growth and development. Amino acids can, directly and indirectly, influence plant growth and development by affecting plant physiological activities. It was found that the foliar application of amino acid is beneficial for vegetative and reproductive growth as well as the yield quality of grapes (Khan et al; 2012). CPPA (Complex Polymeric Polyhydroxy Acid) is a group of organic acids that enhance various plant physiological functions such as nutrient absorption, shoot, and root growth. Figure 9 shows the visual comparison of seedling growth in different treatments after 12 days of seed treatment application and seed sowing. These figures visualize the impact of different fertilizer products on wheat seedling growth and development.

7. Conclusion

This trial was conducted to assess the effectiveness of different fertilizer products on wheat germination and seedling growth. The results revealed that the application of Transit Zn and CPPA greatly improved the shoot length. Also, Transit Zn, CPPA, Amino Boost Transit Max, and Momentum ZnP resulted in significantly the highest root length. Hence, it can be concluded that Transit Zn and CPPA are excellent products for wheat seedling growth and development. Also, Amino Boost Transit Max and Momentum ZnP are other good options for wheat growth and development in the early stages. However, there was no significant difference found between treatments in seed germination, and all treatments performed well.

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