https://doi.org/10.1051/e3sconf/202236104001

Growth performance of 'Mentik Wangi' rice (*Oryza sativa* L.) with Zn nano application on drought stress.

Abdul Ghaffar Amiruddin Zaki[1,*], Amalia Tetrani Sakya [2], Bambang Pujiasmanto [2.]
[1] Department of Agronomy, Faculty of Agriculture, Sebelas Maret University. Surakarta, Indonesia, 57126
[2] Department of Agrotechnology, Faculty of Agriculture, Sebelas Maret University. Surakarta, Indonesia, 57126

Abstract. Mentik wangi rice (*Oryza sativa* L.) is a variety originating from Magelang Regency, Central Java. Mentik wangi has the advantages of fragrant smell, fluffier texture, and high market demand. The weakness of mentik wangi rice is long life (4 months), long stems, easy collapse. The problem of long-lived rice if the planting period enters the dry season and the availability of water is limited, it will have an impact on productivity. This study aims to overcome problems by applying Zn nano to drought stress. Zn is one of plant microelements that functions as auxin biosynthesis, cell elongation, stem segments, and enzyme activator. Enzyme activators function in slowing the increase in reactive oxygen species (ROS) during drought stress, maintaining physiological resistance and rice growth. The study was conducted with a factorial completely randomized design in a screen house. The results showed Zn nano maintains yield and plant growth under stress. The most optimal dose. However, there is a tendency at the 3.75 ppm Zn nano dose to get low yields, it is suspected that if an excessive dose of Zn causes poisoning in plants. The application of Zn nano is optimal when applied under stressed conditions compared to normal conditions.

1 Introduction

Rice (*Oryza sativa L.*) is a source of staple food for the people of Indonesia. Rice is spread in tropical to sub-tropical regions[1]. Rice has various types of varieties, one of which is the local variety of ‘mentik wangi’ rice. Mentik wangi rice has a fragrant smell, fluffier texture, and high public interest. The demand for high rice is not proportional to its production. Rice productivity is influenced by external factors and internal factors. Internal factors of rice productivity such as phytohormones and varieties. External factors such as water, nutrients, light intensity, soil pH, soil and air temperature, and soil and air humidity [2].

Rice grows optimally when water needs are met. Water is an important component for rice growth. Water functions as a photosynthetic material, so the photosynthesis process depends on the conditions of water demand [3]. Plants need less micronutrients, such as Cl, Fe, Mn, Cu, Zn, B, and Mo [4]. Nutrient Zn (Zinc) is one of the micro elements needed by

---

[*] Corresponding author: abdulghaffar_agrs2@student.uns.ac.id

rice plants. Zn functions as enzyme activation and auxin biosynthesis for cell and stem cell elongation. Zn is immobile, so Zn deficiency symptoms are found in young leaves. Zn deficiency inhibits plant growth and weakens growth hormone synthesis[5]. Zn deficiency is generally caused by high pH alkaline soil, calcareous soil, and low cation exchange capacity (CEC) [6]. Zn acts as an activator of enzymes such as superoxide enzymes that can slow the increase in ROS during drought stress.

The addition of Zn nutrients to mentik wangi rice is expected to increase physiological resistance and yield under stressed conditions. The use of Zn nano is expected to be more specific. This can be applied in the field to determine the conditions of drought stress and solutions to these problems. Information on the response of rice plants to drought stress and Zn nano nutrients can be used as a basis for information to overcome rice experiencing drought stress. In addition, this research is intended to prepare for rice planting in areas with high drought stress and Zn nano nutrients.

2 Materials and method

2.1 Research Time and Place

The research was carried out in September 2021-January 2022 at the Experimental Garden Field of the Faculty of Agriculture, Universitas Sebelas Maret (UNS), Sukosari Village, Jumantono District, Karanganyar Regency. Jumantono research area is located at 7^o 37’ 48,3” south latitude dan 110^o 56’ 52,2” east longitude. The research area is located at an altitude of 170 meters above sea level (masl). The type of soil in the experimental garden includes alfisols. The average temperature in collection data is 33°C and average air moisture is 55%.

2.2 Research Materials and Tools

The tools used in this study include seedling trays, analytical scales, measuring jugs, agricultural tools, stationery, meters, cameras, and ovens. The materials used in the research were mentik wangi rice seeds, Zn nano powder Zinc oxide (Zn2O3) fertilizer.

2.3 Research Design

This study used an environmental design in the form of a Completely Randomized Design (CRD). Planting of 3 polybags per treatment (3 replicates). Stress treatment level, (A0: Stressed Condition, A1: Normal condition). Determination of water content using the gravimetric method, gravimetry itself is a method of measuring ground water loss (comparison between normal conditions and conditions that have been dried).The application of watering every 3 days, after passing the critical phase of rice plants about 20 to 95 day. Zn treatment level (B): B0: 0 ppm, B1: 0.75 ppm, B2: 1.5 ppm, B3: 2.25 ppm, B4: 3 ppm, B5: 3.75 ppm. Data analysis using ANOVA (analysis of variance) with a level of 5%. -If there is significantly affect a, it will be continued with the DMRT test. This test was carried out at a 5% level.

3 Result and discussion

3.1 Plant Height

Rice plant height is classified into several categories, such as short stems (<110 cm), medium (110-130 cm), and tall (>130 cm). plant height correlated with the success rate of harvest [7].

Table 1. Effect of application Zn nano on drought stress to plant height mentik wangi rice.

Plant Height (Cm)						
	Zn nano Dosage (ppm)					
Field Capacity	0	0.75	1.5	2.25	3	3.75
Stress (50%)	105.17abc	95.33a	105.83abc	106bc	104.67abc	106.67c
Normal (100%)	96ab	108.67c	104.17abc	104.5abc	103abc	111c

Note: Same column indicate a significant difference in DMRT 5% level.

Table 1 explains that in the application of Zn nano 3.75 ppm under normal conditions, mentik wangi rice has the highest plant height yield. Meanwhile, the application of 0.75 ppm Zn nano under stressed conditions had the shortest plant height yield. Rice plants grow optimally when under normal conditions, namely in conditions that are not flooded and not stressed by drought. Rice growth will be stable under normal conditions [8]. The application of Zn nutrients affects the plant height of mentik wangi rice plants under stressed conditions. It can be seen from the results of Table 1 that the height of rice plants under stress conditions with the application of Zn nano obtained results that were not much different under normal conditions. The application of Zn fertilizer did not significantly affect the growth of rice plant height, but the addition of Zn got better results than control [9]. Not all doses have effect just in Table 1.

The application of Zn nano doses with the right composition can keep plants under stress. The addition of Zn fertilizer affects rice growth and Zn plays an important role in maintaining good plant conditions [10]. The best rice plant height in stressed conditions was with the addition of a dose of Zn nano 3.75 ppm although it is not significant. This explains that with this treatment, the highest of mentik wangi rice plant length was obtained, both under stressed conditions and under normal conditions.

3.2 Root Length

The root is a part of the plant that functions as a support for the main stem through a gripping mechanism on the surface layer, so that the tree does not fall easily. The length and spread of the roots affect the ability to support and survive the plant [11].

Table 2. Effect of application Zn nano on drought stress to root length mentik wangi rice.

Root Length (Cm)						
	Zn nano Dosage (ppm)					
Field Capacity	0	0.75	1.5	2.25	3	3.75
Stress (50%)	28a	19.67a	21.33a	19.33a	27.33a	18.67a
Normal (100%)	21.33a	19.33a	23.67a	30.67a	23.67a	16.67a

Note: Same column indicate a significant difference in DMRT 5% level.

Table 2 explains that the treatment with the application of a 2.25 ppm Zn nano dose under normal conditions has the longest root length of the mentik wangi rice plant. Meanwhile, the application of Zn nano 3.75 ppm under normal conditions actually got the shortest roots length results. In general, the results of the application of Zn nano under normal and stressed conditions did not show a significant difference. It is suspected that the application of Zn fertilizer both under stressed and normal conditions through stomata did not significantly affect the root length of each mentik wangi rice plant. However, giving an excessive dose of Zn actually causes a decrease in root length, this is thought to be due to toxicity. An increase in the content of Zn causes toxicity to chlorosis in young leaves, due to the effect on deficiency of other elements and factors. Soil environmental factors also affect the availability of Zn nutrients [12]. The micronutrient Zn is very important for plants in small amounts. Zn deficiency can inhibit cell division and root biomass and have an impact on nutrient absorption, photosynthesis and plant productivity [13]. Water stress causes a decrease in chlorophyll. Chlorophyll is a component of chloroplasts and its content is correlated with the rate of photosynthesis and plant growth, one of which is root length.

3.3 Panicle

The productivity of mentik wangi rice is influenced by several factors, one of which is the number and length of panicles. The length of the panicle affects the amount of grain produced, the longer the panicle, the greater the number of grains per panicle.[14]

Table 3. Effect of application Zn nano on drought stress to number of panicle and panicle length mentik wangi rice.

Number of Panicle						
	Zn nano Dosage (ppm)					
Field Capacity	0	0.75	1.5	2.25	3	3.75
Stress (50%)	27c	26.33bc	19ab	24.67abc	20.67abc	18.67a
Normal (100%)	19.67abc	25abc	23.33abc	25.33abc	23abc	22.33abc
Panicle Length (Cm)						
	Zn nano Dosage (ppm)					
Field Capacity	0	0.75	1.5	2.25	3	3.75
Stress (50%)	22.33ab	21.67a	22.67abc	22.33ab	23.67abcd	25d
Normal (100%)	22.33ab	23.33abcd	24.33bcd	23.67abcd	22.67abc	24.67cd

Note: Same column indicate a significant difference in DMRT 5% level.

Table 3 explains that the treatment without application of Zn nano under stressed conditions had the highest number of panicles compared to other treatments. Meanwhile, in the application treatment of 3.75 ppm Zn nano under stressed conditions, it actually got the least number of panicles, but the treatment had the longest panicle length. The application of zn decrease affects the number of panicles of mentik wangi rice. The addition of Zn fertilizer can increase affect panicle length, harvest time, grain weight, number of panicle grains.

The application of excessive doses of Zn overall caused the number of panicles of the mentik wangi rice plant to be less than optimal, even though it had a high panicle length. This also affects the productivity of mentik wangi rice both under normal and stressed conditions. The condition of flooded land at primordial time can interfere with panicle formation in rice plants [10]. Because submerged conditions cause rice to adapt to growth, one of which is the number of panicles. The results of the number and length of panicles from Table 3 are generally contradictory. The results of the treatment with the highest number of panicles had a short panicle length and vice versa if the number of panicles was small, had a long panicle length.

3.4 Numbers of productive tillers

Observation of the number of productive tillers was carried out by counting productive tillers in a single clump of rice that produced pithy grains. Productive tillers appear just before entering the generative phase or panicle formation. The application of Zn fertilizer has a significant effect on the number of productive tillers [9].

Table 4 explains that the treatment with 0.75 ppm Zn nano application under normal conditions had the highest number of productive tillers compared to other treatments. In contrast to the treatment, the application of 3.75 ppm Zn nano under stressed conditions resulted in the least number of productive tillers. There are significant differences in each treatment, due to the effect of the application of Zn nano at each dose. The addition of Zn has a significant effect on the number of tillers produced [9].

Table 4. Effect of application Zn nano on drought stress to numbers of productive tillers mentik wangi rice.

Numbers of productive tillers						
	Zn nano Dosage (ppm)					
Field Capacity	0	0.75	1.5	2.25	3	3.75
Stress (50%)	20.67de	20.33cde	14.67ab	18.66abcde	16.33abcd	14.33a
Normal (100%)	15.33abc	22.67e	19.33abcde	21.00de	17.33abcd	19.67 bcde

Note: Same column indicate a significant difference in DMRT 5% level.

The addition of Zn through stomata can be absorbed easily by plants. The addition of the right dose of Zn for rice plants can produce a large number of tillers. The addition of Zn can increase the number of shoots [15]. The addition of an inappropriate dose of Zn can reduce the number of productive tillers produced. The addition of an excessive dose of Zn in stressed conditions can actually cause a decrease in the number of productive tillers. If the dose added is not appropriate, it is suspected that it will be toxic, causing the tillers to be less productive. If the concentration of Zn in the soil is high, it can affect the absorption of Zn into plant tissues [16].

3.5 Weight of stover

Observation of the number of productive tillers was carried out by counting productive tillers in a single clump of rice that produced pithy grains. Productive tillers appear just before entering the generative phase or panicle formation. Dry stover is a picture of nutrients transported by plants and circulated to all parts of the plant, so that the highest weight of stover is the result of optimal nutrient absorption by plants [17].

Table 5. Effect of application Zn nano on drought stress to weight of stovers mentik wangi rice (*Oryza sativa*).

Weight of Stover (g)						
	Zn nano Dosage (ppm)					
Field Capacity	0	0.75	1.5	2.25	3	3.75
Stress (50%)	293.33c	262bc	179.67ab	250.67abc	227.67abc	152.67a
Normal (100%)	159a	318.67c	281bc	241abc	247.33abc	233abc

Note: Same column indicate a significant difference in DMRT 5% level.

Table 5 explains that in the treatment of 0.75 ppm Zn nano application under normal conditions, mentik wangi rice obtained the highest dry weight of stover. However, in the treatment without the addition of Zn under normal conditions, the results of the lowest dry stover weight were obtained, except for treatment dose Zn of 3,75 ppm in stress condition. The provision of Zn nutrients affects the yield of the rice plant bran stover. Plant stover as an indicator of the plant's metabolic process. Giving Zn plays an important role in maintaining and increasing metabolic processes in rice plants. Zn plays a role in the carbohydrate metabolism of rice plants during the process of photosynthesis and changes in sugar to starch, also plays a role in the process of hormone synthesis and biochemical processes [18].

The addition of Zn has a significant effect on the weight of the stove. This is indicated by the difference in the weight of the stover in the same field conditions as the Zn dose application. Excessive watering of the land causes the availability of Zn to decrease, so it is necessary to add Zn nutrients to maintain the condition of the rice plant. Continuous flooding of land causes the availability of Zn to decrease and the content of phosphorus (P) is high resulting in low Zn absorption, because Zn is bound to P to form P-Zn [19]. Because irrigation can increase the weight of the stove, but if excessive watering can reduce the content of zn, so that under these conditions it is necessary to apply Zn nano to maintain the absorption of Zn.

3.6 Weight 1000 seeds

The weight of 1000 seeds are a calculation to determine the potential yield of rice production. Rice production can be determined by weighing the weight of the rice grains by taking 1000 grains of rice. The average weight of 1000 seeds can be seen from the condition of the seeds produced by the rice plant. The greater the seed weight of a plant affects the weight of 1000 plant seeds. However, seed weight per plant was negatively correlated with harvest age and weight of 1000 seeds[20].

Table 6. Effect of application Zn nano on drought stress to Weight 1000 seeds mentik wangi rice.

Weight 1000 seeds (g)						
	Zn nano Dosage (ppm)					
Field Capacity	0	0.75	1.5	2.25	3	3.75
Stress (50%)	3.15a	3.07a	2.87a	3.01a	3.03a	2.97a
Normal (100%)	2.97a	3.75b	3.05a	3.17a	2.99a	3.09a

Note: Same column indicate a significant difference in DMRT 5% level.

Table 6 explains that in the treatment of 0.75 ppm Zn nano application under normal conditions, mentik wangi rice obtained the highest yield of 1000 seeds. However, the yield of 1000 seeds in each treatment with various Zn doses and conditions was not significant. This explains that the application of Zn to f mentik wangi rice with various doses can maintain the yield of rice production when conditions are stressed. Because the results from stressed conditions and normal conditions were not significantly different, it can be ascertained that the addition of Zn nano had an effect on maintaining the results obtained in stressed conditions.

The weight of 1000 seeds are an indicator to describe the productivity of rice plants in general. Weight of 1000 seeds is a component related to the number of grains per panicle, weight of grain per hectare, and percentage of pithy grain and [10].

The application of Zn nano on mentik wangi rice plants under stressful conditions can help maintain and maintain crop yields, such as the weight of rice grain. The application of Zn nano on the mentik wangi rice plant will be more effective if it is under stress, than under normal conditions. Zn helps maintain plant metabolism, such as the process of photosynthesis to produce carbohydrates. Zn is one of the essential micro-nutrients for plants. Zn deficiency causes low zinc levels and decreased genetic expression. Spraying Zn on rice plants can significantly increase rice yield per hectare [21]. Zn acts as a cofactor and activates enzymes for auxin formation, fruit formation, and cell differentiation. Zn also functions as a catalyst for carbohydrate metabolism, but not all additions of Zn fertilizer can help enzyme activity and plant metabolism[22].

4 Conclusion

The conclusions of this study are as follows the application of Zn nano can maintain and maintain the productivity results of mentik wangi rice, including plant height, root length, number and length of panicles, number of productive tillers, weight of stover, and weight of grain under stressed conditions. Because the results of stressed conditions and normal conditions in general are not much different. So that the application of Zn nano to maintain the growth and yield of rice plants has been achieved. The use of Zn nano is more effective when used under drought stress conditions, compared to normal conditions. However, there is a tendency at the 3.75 ppm Zn nano dose to get low yields, it is suspected that if an excessive dose of Zn causes poisoning in plants. The application of Zn nano is optimal when applied under stressed conditions compared to normal conditions.

References

1. *J.* Sopialena, *Agrifor* **14,** 2 (2015)
2. S. Mahananto, Sutrisno, and C.F Ananda, *J. Wacana* **12**,1 (2009)
3. *J.* Pertamawati, *STI* **12**,1(2010)
4. E. Tando, *J. Buana Sains* **18**, 2 (2018)
5. F. Fauziah, R. Wulansari, and E. Rezamela, *J. Agrikul* **29,** 1 (2018)
6. S. Juliati, *J. Hort* **18**, 4 (2008)
7. G. R. Sadimantara, W. Nuraida, N.W.S. Suliartini, and Muhidin, in *IOP Conf EES*, **157**, 1 (2018)
8. Ikhwani, G.R. Pratiwi, and A. K. Makarim, *J. TL* **11**,1 (2009)
9. Sunar, T.R Gustina, and Nikmah, *J. Agrisia* **14**,1 (2021)
10. T. Anditasari, Ardian, Idwar, *J.Faperta* **3,** 1 (2016)
11. I.G.M.A. Parwata, B.B Santoso, and I.N. Soemeinaboedhy, *J SainsTekLing*, **3**,2 (2017)
12. R. Santi, J. Benny, R. Hindersah, and D. Nusyamsi, *J Agro* **11**,1 (2015)
13. Y. Juwita and Yustisia, *J Triton* **9**,2 (2018)
14. A. Hambali and I. Lubis, *J Agrohorti* **3**,2 (2015)
15. E. Rezamela, Y. Rachmiati, and T. Trikamulya, *J IBC* **5**,2 (2018)
16. S. Virzelina, G. Tampubolon, and H. Nasution, *J Agroecotenia*, **2**,1 (2019)
17. M.C.I chsan, I. Santoso, and Oktarina, *J Agritrop* **1**,1 (2016)
18. A. Yuniarti and E. Kaya, *J BP* **11**,1 (2015)
19. K. Damayanti, H. hanum, and A. Lubis, *J AgroEko* **4**,3 (2016)
20. B. Suroso and A.J Sodik, *J Agritrop*, 124–133, (2016)
21. M. Hamam, B. Pujiasmanto, and Supriyono, *J AgroIndo* **45**,3 (2018)
22. A.P.D Nazari, Rusdiansyah, A.P.M.S Siregar, and A Rahmi, *J Ziraah* **45**,3 (2020)