J. of Plant Production, Mansoura Univ.,Vol 10 (12):1169 -1173, 2019

Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Effect of Seed Soaking and Foliar Application with Zinc Sulfate on Rice Seedling Strength, Yield and Its Components

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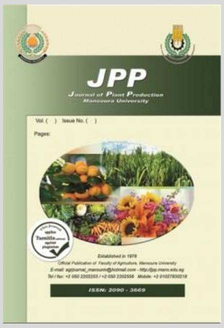

ABSTRACT

Extremely declining zinc is so prevalent in soils particularly in Egypt and affects the production of rice. Field trials were performed at El-Senblawin, Dakahlia Governorate 2017 and 2018 seasons to evaluate the influences of different methods of Zn application on rice growth and yield characteristics. The experiment included Zn seed soaking and foliar applications. Soaking treatments, 0, 50, 100, 200 mg/L $ZnSO_4$, and recommend mineral & Zinc nanoparticle treatments as foliar, 0, 30, 60 mg/L, and zinc sulphate. Split plot design were used in three replications. Results showed significant in two seasons at seed soaking and foliar treats. The seed soaking in 200 mg/L $ZnSO_4$ increased plant height, tillers/hill, grains/panicle, weight of grains/panicle, 1000 kernel weight, and total grain yield (t/fed) of rice among the different of Zn application in two seasons. Use 60 mg/L as foliar is significant seedling development. Also, demonstrated by a positive association between the Zn concentration in germinating seeds and the combined roots and shooting of dry weight after foliar Zn. Four foliar Zn treatments ($ZnSO_4$) were applied to rice plants at different stages of growth. The interaction between seed soaking 200 and foliar 60 mg/L $ZnSO_4$ boost agronomic traits. To conclude, Zn in rice seed can be effectively raised by foliar and soaking. Seeds with high Zn provide both agronomic and nutritional benefits. Since wide spread occurrence of Zn deficiency in human populations is associated with low dietary Zn intake, special attention should be paid to foliar treatments in rice.

Keywords: Rice, ZnSo4, Soaking and foliar

INTRODUCTION

Rice (Oryza sativa L.) is the principal source of income for many people.

Rice plays a key role in Egypt's food security. Improved production of rice can be accomplished by using high yielding cultivars and optimizing the cultural practices such as seed soaking and foliar treatments. The launch of Sakha 104 rice cultivar increased yields by around 15-20 percent more than the promising high-yielding commercial cultivar Zayed *et al.,* (2006) and Zayed *et al.,* (2010). The overall cultivated field with rice in Egypt is around 724,200 feddan (2018) with an average 5 tonnes/feddan. Foliar application of Zn was added 0.5 % ($ZnSO_4$ during plant development, mid-tillering and panicle initiation. Dissolving $ZnSO_4$ powder with distilled deionized water to get the solution. The formulation was applied by splash the solvent uniformly on plants and the solvent was only beginning to leak from the leaves, about 10 a.m. in the morning. The irrigation volume was 900-1000 L ha^{-1}. Recently, Zn is ranked to be the fourth essential yield-limiting nutrient after nitrogen, phosphorus and potassium. For the creation of chlorophyll, fertilization, pollination and germination Zink is needed. Also, play key role in growth of biomass from seed to seeds (Cakmak 2000; Broadley *et al.*, 2007). Zn have reduced seedling intensity and Zn-deficient soil field formation. Zn enhance the germination because enter of metal ions so can be utilized the seedling establishment. (Coleman 1998) Recorded that Zn seed priming was useful for boosting germination and barely growth and these may suggest that high concentrations of Zn in seeds during germination and early seedling growth have critical physiological functions.

Treatments rice seeds by Zink boost yields and economical alternative to costly applicatio ns of Zn fertilizers Slaton *et al.*, (1999). Gene expression and protein synthesis depend on Zn in plants (Cakmak 2000; Broadley *et al.*, 2007). This dimension was also indicated as cofactor in more with more than 300 metabolites (Coleman 1998). The development of reactive oxygen species (ROS) is well known during germination (Cakmak *et al.*, 1993; Bailly *et al.*, 2002; Qin and Liu 2010). Also, plays key role in plant cell detoxification of (ROS) (Cakmak 2000; Broadley *et al.*, 2007). EL -Ekhtyar *et al.*, (2008) reported that pre-seed sowing by $ZnSO_4$, achieve significant panicle number, panicle weight, filled grain and 1000-grain weight. The aim of work to study the impact of zinc on rice seed germination, seedling establishment and yield characteristics through seed soaking and foliar application.

MATERIALS AND METHODS

Field experiments were carried out at EL Senblawin, Dakahlia Governorate during 2017 and 2018 seasons to performance the production (Sakha104) The experiments were carried out in split plot design in three

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DOI: 10.21608/jpp.2019.82563

replications 1- The main plots were allocated to the five seed soaking treatments as follows [Without, 50 mg /L $ZnSO_4$, 100 mg/L, 200 mg/L $ZnSO_4$, Recommend Mineral Zinc]. The sub-plots were allocated to foliar applications as follows [Without, 30 mg L^{-1}, 60 mg L^{-1}, Mineral Zinc].

The rice seeds of Sakha 104 were collected from Agricultural Research Center (ARC). The experimental plot area was 3.0 m wide and 3.5 m long, plot area 10.5 m^2.

Wheat was the previous winter crop during both seasons. The soil was clay and had a pH of 8.2 and 7.99 respectively. Preparation for the seedbed. The nursery was well done. Until ploughing, the nursery field was fertilized with calcium superphosphate at a rate of 4 kg/kirat (kirat=175 m^2). Nitrogen in the form of ammonium sulfate (20.5% N) was applied at a rate of 6 kg/kirat and Zink sulphate (24% Zn SO_4) at a rate of 1 kg/kirat. Weeds were chemically regulated at a rate of 2 liters of Saturn 50% dissolved in 100 liters of water/fed and sprayed seven days after sowing. Foliar application with a solution of 0.5 % zinc sulfate at various periods through plant growth was added in mid-tillering and panicle initiation. The foliar treatment was applied by spraying the solvent uniformly bath all plants and the solvent had begun trickle out the leaves, about 10 a.m. in the morning. Calcium superphosphate (15.5 % P_2O_5) was applied to the permanent land at a rate of 100 kg/ fed on dry soil before ploughing. Nitrogen was inserted in two equivalent parts at a rate of 60 kg N/fed in the form of Urea (46 % N). The first part was added two weeks after transplanting and the second part was added 20 days after the first one. Thirty days old seedlings were transplanted at a rate of 4-5 seedlings/hill adopting a spacing of 20x20 cm, which were sown randomly with the rate of 25 hills /m^2, with 2-3cm of the standing water on the land surface. Normal watering management, at four days to six was followed. The weeds were chemically controlled with Saturn 50% as mentioned after transplanting with four days. Data recorded as follows A. Plant growth Characteristics:1- Plant height 2- Stem diameter 3-Number of tillers/plant. B. Panicle characteristics and grain yield: 1-Panicle length 2- Number of grains/panicle 3- Grains weight/panicle 4-1000-grain weight 5-Grain yield (ton/fed). C. Germination characters 1. Germination percentage: This was calculated by counting only normal seedlings 14 days after sowing (ISTA, Rules 1999) 2. Germination energy: It is the percentage of germinated seeds five days after sowing relative to the total number of seeds (Ruan *et al*., 2002). Germination speed index (GSI): This was calculated according to AOSA (1983) using the following formula:

$$GSI = \frac{\text{Germinated seed}}{\text{Days of first count}} + \frac{\text{Germinated seed}}{\text{Days of final count}}$$

The seeds were considered germinated when the radical was at least 2 mm long. Seedling dry weight (g): Ten normal seedlings were dried in hot-air oven at 65°C for 12 h to obtain the seedling dry weight (g) according to Krishnasamy and Seshu (1990). Split plot design in this study was permitted the statistica analysis of the date by the technique of analysis of variance (ANOVA) in order to the observe treatments effects were real and discernible from chance effects, the null hypothesis was tested by 'F ' test in case where the test revealed significant among treatments with new significant differences (NLSD) at 5% of probability compared to elucidate the nature and magnitude of the treatment effect. (Waller and Duncan 1969).

RESULTS AND DISCUSSION

Several experiments have shown that zinc influences plant metabolism and other of physiological processes with respect to the influence of seed soaking treatments. Data presented in Table 1 effected plant height, stem diameter, panicle length, number of tillers/plant, number of grains/panicle, panicle weight, 1000-grain weight and grain yield in response to soaking and foliar treats. Data collected in both seasons was quite important. There is a substantial change in the length of the radical and shoot with an increase in the concentration of $ZnSO_4$.

Zinc plays a role in preserving and sustaining structural integrity of cell membranes and protein synthesis, membrane function, cell elongation and tolerance to environmental stresses. Wei *et al.,* (2012) were supported this finding. Seeds from Zn is involved in the synthesis of some enzymes, such as carbonic anhydrase, and is expressed in the photosynthesis cycle as CO_2 is expressed. Zn deficiency affects the yield of seed is significantly diminished as it plays a special role in fertilization It has been found that the pollen grain contains a very high percentage of Zn where during fertilization process most of Zn is transferred to the developing seeds. The foliar applications are divided for Nano Zn namely; 30, 60 mg /L, recommended mineral zinc has different effects on change growth; plant height, stem diameter, panicle length, number of tillers/plant, number of grains/panicle, panicle weight, 1000-grain weight and yield. Zn treats were boost seedling weight.

Results indicated that Zn's phloem transfer of leaf and seedling tissues may also enhancing grain zinc enrichment. Phattarakul *et al*., (2012) was shown that soil-applied Zn fertilizers had little effect on Zn grain in rice when spraying Zn to foliage caused very significant increases in grain Zn and the growth conditions have a role in contribution of xylem and phloem transport (remobilization) in grains. Present study reported the timing of foliar application is critical factor in achieving the maximum increase of Zn in grains. High dose of zinc in rice was achieved by foliar applied at different stages as panicle initiation and booting while foliar Zn was applied. The introduction of Zn at an early stage of development such as panicle initiation and/or booting did not affect the concentration of Zn seeds. Once Zn was added at late growth stage (during flowering), there was high in brown rice Zn up to 56 % of Zn comparing at late growth stage (after flowering). It seems that only a small amount of zinc as foliar is translocated into rice after early application while, high amount of Zn is transported into rice grains and penetrate brown rice after late application as foliar. Phattarakul *et al*., (2012) showed that a foliar zinc applied at late growth to rice grown under field conditions significant grains by zinc than a foliar Zn before flowering stage. Similar results were also found in field grown-wheat Cakmak *et al*., (2010a). Statistical analysis of data showed that Zinc nanoparticle has been used in many experiments.

Have low seedling vigor and zinc deficient soil environment. Germination often requires the passage of metal ions such as Zn thus can be used efficiently. In Table 2 germination (%), germination Energy, speed of germination and dry weight was shown in response to $ZnSO_4$ treats when subjected to 0, 50 mg/L, 100 mg/L, 200 mg/L and recommended mineral Zinc of ($ZnSO_4$) in both seasons data obtained was very significant. There is gradual increase in the length of the radical and shoot with increase in the concentration of zinc.

Table 1. Plant height, stem diameter, panicle length, number of tillers/plant, number of grains/panicle, panicle weight,1000-grain weight and yield as affected by seed soaking and foliar application in both seasons.

Characters Treatments	Plant height (cm)		Stem diameter		Panicle length		Number of tillers/ plant		Grain /p		Grains weight /panicle (g)		1000-grain weight		Grains yield	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
A. Seed soaking Nano Zinc																
0	78.5	80.50	3.0	3.5	19	19.50	6	6	85	80	2.0	2.0	19.8	20.1	2.800	2.00
50	81.5	89.5	3.5	4.4	19.5	21.1	7	7	90	88	2.7	2.6	21.2	22.9	2.900	3000
100	88.5	89.5	4.3	4.5	20.2	20	7	7	100	93	2.8	3	22.9	23.2	3.100	3.500
200	95.2	98.3	4.5	4.8	21.2	21.25	9	9	102	104	3.6	3.5	24.2	24	4.200	4.1500
Recomm	77	80.1	4.3	4.5	18.5	18.9	7	8	77	75	2.2	2.3	19.5	19.5	2.900	2.800
NLSD 5 %	N.S	1.46	3.71	5.7	0.88	0.74	0.25	0.27	1.41	1.26	0.35	0.19	1.8	1.51	0.27	0.41
B. Foliar application Nano Zinc																
0	80	81	3.5	3.8	18.5	18.5	6.2	6.2	70	75	2.1	2.0	18.2	19.2	2.800	2.700
30	88	85	3.8	3.8	18.9	18.9	6.5	6.3	78	88	2.3	2.5	20.1	20.2	2.850	2.900
60	90	88	4.2	4.1	19.5	20	7.5	7.5	83	88	3.2	3.8	23.2	22.5	3.000	3.150
Recomm	78	80	3.5	3.4	18.2	18.8	6.8	6.55	73	71	3.0	3.2	22.2	21.2	2.500	2.700
NLSD 5 %	4.3	5.7	N.S	N.S	2.4	2.51	4.0	2.48	1.2	1.13	2.48	4.3	4.2	5.71	0.21	0.23
C. Interactions																
AB	N.S	*	N.S	N.S	N.S	*	N.S	N.S	**	N.S	**	**	**	**	N.S	N.S

Table 2. Germination percentage, germination energy, speed of germination and seedling dry weight as affected by seed soaking and foliar application in both season.

Characters Treatments	Germination (%)		Germination Energy (GE %)		Speed of Germination (SG)		Dry Weight (gm)	
	2017	2018	2017	2018	2017	2018	2017	2018
A. Seed soaking Nano Zinc								
0	75	73	85	81	7.5	7.8	0.11	0.12
50	88	88.7	88	87	7.79	7.5	0.13	0.12
100	90.	91	85	88	8.0	8.1	0.12	0.15
200	94	93	90	91	8.83	8.9	0.18	0.19
Recomm Zn	81	82	81	82	7.9	7.5	0.11	0.10
NLSD 5 %	3.01	1.03	N.S	NS	0.73	0.77	N.S	N.S
B. Foliar application Nano Zinc								
0	75	75	80	78	7.5	7.5	0.11	012
30	85	78	82	85	7.9	7.8	0.13	0.14
60	90	85	88	90	8.5	8.7	0.14	0.14
Recomm Zn	78	75	80	79	7.5	7.5	0.11	0.13
NLSD 5 %	4.06	1.96	4.87	4.08	0.54	0.44	4.04	1.96
C. Interaction								
AB	N.S	**	N.S	N.S	**	**	N.S	N.S

The results obtained revealed that foliar applications were divide for two levels of Zn concentration, intermediate (30 mg Zn/L) and high (60 mg Zn/L), with different effects on the growth of seedlings and changes in Zn concentration in seed germinating. High dose of zinc had effects on growth of seedlings as calculated by root and coleoptile dry weight and seedling establishment (Table 2). Significant increase in seedling weight at high dose of Zn applied. High Zn also promoted root and shoot growth during early days of germination, although this effect disappeared later. Similar results were stated by Ruan and Tylkowska (2002). The findings are from Table 2 of seedlings resulting from high and Intermediate Zn had longer roots than those of low Zn (Table 2). The high dose of zinc can boost rice seedlings comparing low dose. The interaction among the first season the relationship between seed soaking and foliar treatments was significant on plant height (Table 3). In the second season, seed soaking and foliar (60 mg/L) at $ZnSO_4$ culminated in the tallest plants (90.5). In the other hand, it was soaking without zinc that culminated in the shortest rice plants. In the second season the data for this concern were 70.4 cm. Cakmak *et al.,* (2010a) came out similar results.

Table 3. Plant height as affected by the interaction between seed soaking and foliar application of zinc in 2018 season

Seed soaking	2018				
Foliar application	0	50	100	200	Mineral Zinc
0	70.4	74.87	80.5	85.5	75.23
30	74.47	83.80	85.0	89.5	80.80
60	77.0	88.0	88.5	90.5	88.5
Mineral Zinc	72.33	75.87	80.5	83.2	85.47
NLSD 5 %	1.29				

The interaction among seed soaking and foliar treatments in the first season signification the number of grains/panicle (Table 4). The highest numbers of grains/ panicle (120) were register in the first season as zinc sulphate from soaking, 200 mg/L soaking and foliar in application (60 mg/L). On the other hand, the lowest numbers of grains/panicle were resulted from soaking without zinc 80.67and foliar. Similar results stated by Frossard *et al.,* (2000).

Table 4. Number of grains/panicle as affected by the interaction between seed soaking and foliar application of zinc in 2017 season

Seed soaking	2017				
Foliar application	**0**	**50**	**100**	**200**	**Mineral Zinc**
0	80.67	85.0	88	98.9	81.33
30	94.33	100.33	105	110	90.0
60	98	105	115	120	92
Mineral Zinc	82.67	92.67	95.2	100	86.67
NLSD 5 %	6.31				

Results in Table 5 demonstrate that the relationship between foliar and seed soaking treatments during both seasons 2017 and 2018 a major impact on grain weight/ panicle. The maximum grain weight / panicle values (4.04 and 3.9 g) were recorded from in the first and second seasons respectively from foliar application (60 mg/L) at $ZnSO_4$ While, the lowest ones (2,20 and 2,33 g) were given without Zn soaking zinc in the first and second seasons, respectively. Similar results were stated by Ruan *et al*., (2002).

Table 5. Grains weight/panicle as affected by the interaction of seed soaking and foliar application in both seasons

Seed soaking	2017					2018				
Foliar application	**0**	**50**	**100**	**200**	**Mineral Zinc**	**0**	**50**	**100**	**200**	**Mineral Zinc**
0	2.20	2.37	2.5	2.9	2.37	2.33	2.4	2.6	2.8	2.37
30	2.50	3.27	2.8	3.5.0	2.5	2.42	2.78	2.90	3.5	2.74
60	2.55	3.00	3.40	4.04	2.5	2.6	2.7	3.50	3.9	2.8
Mineral Zinc	2.35	2.41	2.85	2.9	2.56	2.40	2.66	2.7	2.88	2.81
NLSD 5 %	0.19					0.17				

The interaction between of this study, the relationship between seed soaking and foliar care exhibited major impact on rice's 1000 grain weight (Table 6). Between the first and second seasons, the heaviest 1000-grain weight (26.8 and 28.0 g) was register under foliar (60 mg Zn/L) in from Zn SO4 and seed soaking 200 mg/L. during the first and second seasons, respectively. The lowest values of 1000-grain weight (19.20 and 19.8 g) were resulted from soaking without zinc and without foliar in the first and second seasons, respectively. Similar results were stated by Wei *et al.*, (2012).

Table 6. 1000-grain weight as affected by seed soaking and foliar application in both seasons.

Seed soaking	2017					2018				
Foliar application	**0**	**50**	**100**	**200**	**Mineral Zinc**	**0**	**50**	**100**	**200**	**Mineral Zinc**
0	19.20	20.93	21	22.5	20.22	19.8	20.23	21.4	21.5	20.26
30	21.77	28.60	22.2	23.5	20.77	21.24	22.00	23.5	25.5	22.50
60	22.5	25.3	24.5	26.8	21.5	22.8	22.2	23.2	28..	23.5
Mineral Zinc	20.30	22.03	22.56	22.70	22.87	22.00	22.63	22.8	23.2	23.83
NLSD 5 %	1.05					0.82				

Table 7 shows the interaction effects of seed soaking and foliar treatments in two seasons important impact on speed of germination (SG). High germination rate (13.8 and 14.4) was recorded in the first and second seasons under foliar (60 mg/L) $ZnSO_4$ respectively, whereas the lowest values (8.10.and 7.67) resulted from soaking without zinc and without foliar in the first and second seasons, respectively. Similar results were stated by Abo-Youssef (2010).

Table 7.Speed of germination as affected by seed soaking and foliar application of zinc in 2017and 2018 seasons

Seed soaking	2017					2018				
Foliar application	**0**	**50**	**100**	**200**	**Mineral Zinc**	**0**	**50**	**100**	**200**	**Mineral Zinc**
0	8.10	8.40	8.7	9.8	8.33	7.67	8.26	8.5	9.8	8.33
30	9.00	8.9	9.2	8.8	8.00	8.50	9.17	10.8	11.5	8.67
60	9.2	9.9	11.5	13.8	9.5	9.5	9.8.	12.5	14.4	8.0
Mineral Zinc	8.53	7.50	8.2	8.9	9.93	7.9	8.3	8.9	9.5	9.27
NLSD 5 %	0.92					0.75				

The interaction between foliar and seed soaking treatments exhibited major influence on rice germination % in the second season of this study in Table 8. The highest speed of germination of rice (95%) was resulted under foliar 60 mg/L $ZnSO_4$ treatment in the second season, whereas the lowest (78.33%) was resulted from soaking without zinc and without foliar application in the first and second seasons, respectively. Similar results were stated by Nasri *et al*., (2011)

Table 8. Germination percentage as affected by interaction of seed soaking and foliar application with zinc in 2018 season

Seed soaking	2018				
Foliar application	**0**	**50**	**100**	**200**	**Mineral Zinc**
0	78.33	79.33	88.5	92.5	78.33
30	79.00	94.33	89.5	93.2	83.67
60	80.52	82.5	90.5	95.0	84.5
Mineral Zinc	80.67	84.33	85.5	82.5	84.9
NLSD 5 %	3.33				

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تأثير نقع البذوروالرش الورقي بكبريتات الزنك على قوة بادرات الأرز ومكوناتة

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أقيمت تجربتان حقليتان بمزرعة خاصة بمركز السنبلاوين بمحافظة الدقهلية خلال موسمي 2017 و2018 وذلك لدراسة تاثير معامله نقع البذور والرش الورقي بكبريتات الزنك على صفات المحصول ومكوناتة لصنف الأرز سخا 104 في تصميم القطع المنشقة مرة واحدة في ثلاثة مكررات حيث شملت القطع الرئيسية معاملات النقع 1- نقع فى الماء (الكنترول)2-النقع في50 مللجرام لتر كبريتات الزنك النانو3- النقع في 100 مللجرام لتر كبريتات الزنك النانو4-النقع في 200 مللجرام لتر من كبريتات الزنك النانو5-النقع كبريتات الزنك العادية الموصي بها للفدان 10كم أما القطع الشقية فاشتملت علي الرش الورقي 1- بدون رش 2-الرش ب30ملليجرام لتر من الزنك النانو 3-الرش ب 60 ملليجرام لتر من الزنك النانو 4- والرش بكبريتات الزنك العادي الموصي بها للفدان 10كم. وكانت أهم النتائج المتحصل عليها فيما يلى: ادى استخدام معاملة النقع التقاوى فى كبريتات الزنك النانو عند تركير 200 ملليجرام / لتر الي تفوقها بالمقارنة بالمعاملات الاخري الى زيادة معنوية فى كل الصفات المدروسة فى كلا الموسمين - لوحظ وجود تاثير معنوى للتفاعل بين المعاملة النقع والرش فى موسم 2018 لطول النبات ونسبة الانبات - لوحظ تاثير معنوى للتفاعل المعنوي بين المعاملة النقع والرش فى موسم 2017 لعدد حبوب الدالية - لوحظ وجود تاثير معنوى للتفاعل المعنوي بين المعاملة. النقع والرش فى كلا الموسمين واعطى اعلى القيم وزن الالف حبة و وزن حبوب الدالية . ودليل سرعه الانبات. من النتائج المتحصل عليها فى هذة الدراسة يوصى بزراعة صنف الارز سخا 104 مع نقع التقاوى فى كبريتات الزنك النانو 200ملليجرام /لتروالرش الورقي بمعدل 60ملليجرام/لتر عند عمر 40 و70 يوم من الزراعة وذلك تحت ظروف محافظة الدقهلية.