A study on the effect of different zinc fertilizer levels on rice grain quality traits

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ABSTRACT

A field experiment was carried out to study the effect of different zinc fertilizer levels on rice grain quality traits at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during the two growing seasons of 2011 and 2012. Seven rice cultivars (Sakha 102, Sakha 105, Sakha 106, Giza 177, Giza 178, Giza 179, Giza 182 besides Hybrid 1) were used and evaluated under four Zinc fertilization rates, (0, 50, 100 and 150%) of the recommended rate (10 kg Zn So_4/fed).

The results revealed that there were significant differences among tested cultivars in respect to all studied characters. This was expected due to their completely different in genetic background.

Increasing zinc level up to 150% of the recommended rate mostly affects all rice grain quality (dimention, milling recovery, cooking and eating quality characters) in the two seasons of study.

Meanwhile, the results indicated that the interaction between rice cultivars and zinc levels was significant in most cases, except grain shape, hulling (%), and gelatinization temperature in the two seasons of study.

From another point of view, the results revealed that decreasing zinc level fertilizer dose to 50% of the recommended did not affect the mean values of most of studied characters in case of Giza 178 followed by Sakha 105 and Sakha 106 in the two seasons. This result indicated that these three cultivars could be recommended as low input cultivars

INTRODUCTION

Rice (*Oryza sativa, L.*) is one of the most important staple food crops of the world. More than two thirds of the world population relies of nutritional benefit of rice. In Egypt, rice is considered as a one of the most essential field crop not only as a food crop but also a land reclamation crop and for exportation.

Rice production depends on several factors, such as climate, physical conditions of the soil, soil fertility, water management, sowing date, cultivars, seed rate, weed control, and fertilization **(Angus *et al*. 1994 and Jing *et al*. 2008).**

Fertilizer is very important input for intensive rice production. The profitability of rice production systems depends on yield and input quantities. So the appropriate fertilizer input that is not only for getting

high grain yield but also for attaining maximum profertility. Nitrogen (N), phosphorus (P) and potash (K) fertilizer is a major essential plant nutrient and key input for in increasing rice yield. Besides, zinc (Zn) was recognized as an essential micronutrient. It serves in various biochemical processes in the rice plant. Zinc deficiency in crop plants reduces not only grain yield, but also the nutrional quality of grains.

Rice is one of highly sensitive crops to zinc deficiency, and zinc is the most important micronutrient limiting rice growth and yield. Reports showed that 30% of the soils in the world exhibit Zinc deficiency to different extents.

Therefore, with the lake of information about the effect of zinc fertilization on rice grain quality characters, the present investigation aimed to study the performance of some Egyptian rice cultivars grown under different zinc fertilizer levels including lower and higher levels than the recommended dose as a step to breed low input rice varieties.

MATERIALS AND METHODS

Two field experiments on rice crop *(Oryza sativa* L.*)* were conducted during two rice growing seasons, 2011 and 2012 at the Research Farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt to study the performance of some Egyptian rice cultivars grown under different zinc fertilizer levels includes lower and higher doses than the recommended.

Treatments and experimental design:

Seven Egyptian rice cultivars namely; Sakha 102, Sakha 105, Sakha 106, Giza 177, Giza 178, Giza 179 and Giza 182 besides Hybrid 1 were utilized in the present study. Table (1) represents parentage and variety group of these cultivars.

Table (1): Origin, parentage and variety group of the studied cultivars

Cultivars	Parentage	Variety group
Hybrid 1	IR 69625A/Giza 178	Indica /Japonica
Sakha 102	GZ 4096-7-1/Sakha 103	Japonica
Sakha 105	GZ5581-46-3/GZ 4316-7-1-1	Japonica
Sakha 106	Giza 177/Hexi30	Japonica
Giza 177	Giza 171/Yomio No.1//Pi No.4	Japonica
Giza 178	Giza 175/Milyang 49	Indica /Japonica
Giza 179	GZ1368-S-5-4/IRAT 112	Indica /Japonica
Giza 182	Giza 181/IR 39422-161-1-3//Giza181	Indica

These cultivars were tested under four levels of zinc. (0, 50, 100 and 150 %) of the recommended rate (10 Zn SO_4/fed).

The experimental design was **split plot design** with three replicates. Rice cultivars represented the main plots; while, the zinc fertilization

rates represented the sub-plot. The total experimental plots were (4 x 8 x 3) = 96 plots with plot area of 1m x 5m = $5m^2$ for experimental unit.
Seeds of the tested cultivars were directly drilled with the seed rate of 50 kg/fed, for the two seasons in one meter length rows with 20 cm apart between rows after better soil tillage.
Nitrogen fertilization, as Urea [CO $(NH_2)_2$ – 46.5%N] was added in three equal doses at recommended times.
Zinc fertilization, as zinc sulfate (Zn SO_4-22% Zn) with the rate of (10 kg Zn SO_4/fed) was added as soil application after soil leveling and just before seed drilling.
Phosphorus fertilization, as calcium super phosphate (15.5% P_2O_5) with the rate of (15.5 kg P_2O_5/fed) was added to the soil before tillage.
Irrigation water requirements and irrigation intervals as well as all the other agronomic practices have been applied according to the recommended methods of rice production.

Statistical analysis:

The analysis of variance was carried out according to the proceeding described by **Gommez and Gomez (1984).** All statically analysis was performed using analysis of variance technique by means of "CO-STAT" computer software package. Treatment means were compared by the least significant differences (LSD) test as given by **Steel and Torrie (1980). Studied Characters:**

Grain quality characters:

1. Grain appearance characters:

a. Grain length (L) (mm): The average of ten well formed brown grains (after dehulling), was measured from the base to the top of these grains by "Micrometer" according to **Chang and Bardenas (1965).**

b. Grain width (W) (mm):

It was measured as the average of ten brown grains (after dehulling) as the distance between the two sides at the widest point of the grain according to **Chang and Bardenas (1965).**

c. Grain shape (L/W ratio):

Grain shape was expressed as the ratio between grain length and width. It was recorded as an average of ten brown grains/plot. As suggested by **Khush *et al.* (1979).**

2. Milling recovery characters:

Hulling percentage (%), milling percentage (%) and head rice percentage (%) were estimated according to the methods reported by **Adair (1952)**.

- Hulling % $= \frac{\text{Brown rice grain weight)}}{\text{Total rough rice grains weight}} \times 100$

- Milling % $= \frac{\text{Milled rice grain weight)}}{\text{Total rough rice grains weight}} \times 100$
- Head Rice % $= \frac{\text{Whole milled rice weight)}}{\text{Total rough rice grains weight}} \times 100$

3. Cooking and eating quality characters:

a. Gelatinization temperature (G T):

It was measured according to **Little *et al*. 1958.**

b. Kernel elongation (%):

Kernel elongation percentage was evaluated according to the follows formula:

Kernel Elongation %= $\frac{\text{milled grain Avg.length b.c.-milled grain Avg.length a.c.}}{\text{milled grain Avg.length b.c.}} \times 100$

Whereas: b.c: Before cooking a.c: After cooking

c. Amylose content (%):

Amylose content was determined according to **(Williams *et al.*, 1958).**

RESULTS AND DISCUSSION

1. Grain dimention characters:

a. Cultivar effects:

Data presented in Table (2) indicated that significant differences among rice cultivars were recorded for grain length character in both seasons. The rice cultivar Giza 182 gained the longest grain length values (6.91 and 6.26 mm), while the rice cultivar Giza 178 recorded the lowest values (5.24 and 4.91mm) in the two seasons, respectively.

Moreover, data presented in Table (2) cleared that grain width was significantly influenced by rice cultivars in both seasons. Sakha 106 rice cultivar obtained the widest grain (2.94 and 2.74 mm) while Giza 182 rice cultivar gave the narrowest grain (2.33 and 2.17 mm), in the two season, respectively.

In addition, the results in Table (2) indicated that significant differences among rice cultivars were obtained in both seasons, for grain shape. Giza 182 rice cultivar obtained the highest grain shape (2.96 and 2.88), while Sakha 106 rice cultivar was the lowest one (1.88 and 1.89).

This difference among the mean values of the studied cultivars in respect to grain appearance characters might be due to genetic differences.

Table (2): Grain length (L) (mm), grain width (W) (mm) and grain shape (L/W ratio) as affected by cultivar, zinc rates as well as their interactions during 2011 and 2012 seasons

Character	Grain length (mm)		Grain width (mm)		Grain shape (L/W ratio)	
Season	2011	2012	2011	2012	2011	2012
Rice Cultivar (C):						
Hybrid 1	5.76	5.39	2.68	2.47	2.14	2.18
Sakha 102	5.81	5.45	2.93	2.64	1.98	2.05
Sakha 105	5.90	5.45	2.84	2.64	2.07	2.05
Sakha 106	5.53	5.18	2.94	2.74	1.88	1.89
Giza 177	5.63	5.05	2.92	2.67	1.92	1.89
Giza 178	5.24	4.91	2.58	2.56	2.03	1.91
Giza 179	5.90	5.46	2.83	2.55	2.08	2.14
Giza 182	6.91	6.26	2.33	2.17	2.96	2.88
F-test	*	*	*	*	*	*
LSD at 0.05	0.10	0.21	0.03	0.05	0.03	0.07
Zinc fertilization rate (Zn):						
0	5.84	5.27	2.76	2.52	2.11	2.09
50	5.83	5.40	2.77	2.55	2.11	2.12
100	5.82	5.42	2.75	2.56	2.12	2.12
150	5.85	5.48	2.75	2.58	2.13	2.13
F-test	NS	*	NS	NS	NS	NS
LSD at 0.05	-	0.06	-	-	-	-
Interaction:						
C x Zn	*	*	*	*	NS	NS

* and NS indicate P < 0.05 and not significant, respectively.

b. Zinc fertilization rate effects:

In regard to the effect of zinc fertilization rates, Table (2) indicated that significant differences among mean values of grain length were detected as affected by the different rates of zinc. Grain length was increased significantly by increasing zinc fertilization rates and maximized at 150% of the recommended zinc fertilization rate only in the second season. These results are in harmony with the findings of **Shehu *et al.* (2011) and Hasnain and Ali (2013)**, they observed that increasing rates of zinc application significantly increased the kernel length and response was linear in nature.

However, data in Table (2) indicate insignificant differences between zinc fertilization rates regarding to grain width and grain shape in the two seasons. These findings are in contrary with **Shehu *et al.* (2011) and Hasnain and Ali (2013)** they reported that increasing rate of zinc application significantly and linearly affected kernel width compared to control.

c. Interaction effects:

The data presented in Table (3) revealed that interaction between cultivars and zinc fertilization rates was significant effect on grain length character in both seasons. In comparison between the recommended and the suggested level (50%), the data indicated that the mean values of all rice cultivars were not significant to grain length except Sakha 102, Giza 179 and Giza 182 rice cultivars in the first season, and Hybrid 1, Giza 177 and Giza 182 rice cultivars in the second season. All cultivars except the maintained previously can fertilize by the level 50% of zinc fertilizer without affect of grain length.

Table (3): Grain length as affected by cultivar x zinc fertilization rate interaction in 2011 and 2012 seasons

Zinc fertilization rate		Cultivar							
		Hybrid 1	Sakha 102	Sakha 105	Sakha 106	Giza 177	Giza 178	Giza 179	Giza 182
2011	0	5.92	5.73	5.87	5.60	5.65	5.16	5.92	6.88
	50	5.75	5.76	5.91	5.49	5.58	5.24	5.98	6.92
	100	5.73	5.96	5.91	5.53	5.65	5.35	5.79	6.70
	150	5.64	5.80	5.92	5.50	5.65	5.23	5.95	7.16
	LSD at 0.05	0.16							
2012	0	5.15	5.35	5.46	5.21	5.22	4.78	5.10	5.91
	50	5.33	5.37	5.48	5.11	5.21	4.95	5.50	6.22
	100	5.57	5.49	5.36	5.22	4.84	4.82	5.60	6.50
	150	5.50	5.62	5.49	5.18	4.92	5.15	5.66	6.42
	LSD at 0.05	0.22							

Furthermore, the data in Table (4), showed that regarding grain width, interaction between rice cultivars and zinc fertilization rates was significant in 2011 and 2012 seasons. In comparison between the recommended and the suggested level (50%), the data indicated that all rice cultivars were not significantly differed except Hybrid 1 and Giza 179 in the first season, as well as Giza 177 and Giza 182 rice cultivars in the second season. While, the interaction between cultivars and zinc fertilization rates in regard to grain shape was not significant in both seasons. Table (2)

Table (4): Grain width as affected by cultivar x zinc fertilization rate interaction in 2011 and 2012 seasons

Zinc fertilization rate		Cultivar							
		Hybrid 1	Sakha 102	Sakha 105	Sakha 106	Giza 177	Giza 178	Giza 179	Giza 182
2011	0	2.68	2.94	2.84	2.86	2.93	2.57	2.89	2.35
	50	2.64	2.97	2.82	2.95	2.91	2.58	2.96	2.34
	100	2.78	2.92	2.88	2.98	2.85	2.60	2.66	2.30

	150	2.62	2.90	2.82	2.96	3.00	2.58	2.81	2.32
	LSD 0.05	0.07							
2012	0	2.37	2.63	2.63	2.75	2.75	2.49	2.43	2.11
	50	2.47	2.59	2.66	2.76	2.75	2.53	2.52	2.14
	100	2.54	2.65	2.62	2.73	2.56	2.55	2.61	2.25
	150	2.50	2.70	2.68	2.74	2.61	2.68	2.59	2.18
	LSD 0.05	0.10							

2. Milling characters effects:

a. Cultivar effects:

Table (5) indicated that rice cultivar Giza 177 obtained the highest value for hulling percentage (81.07 and 80.26 %), while the rice cultivar Giza 178 recorded the lowest one (78.54 and 78.40 %) in both seasons, respectively.

Moreover, data presented in Table (5) indicated that the differences between the tested cultivars regarding milling (%) were significant in both seasons. Giza 177 rice cultivar recorded the highest values for milling percentage (%), (71.87 and 70.86 %), while Giza 182 rice cultivar recorded the lowest value (68.09 and 67.60 %) for both seasons, respectively.

Additionally, in both seasons there were significant differences among rice cultivars in respect to head rice percentage (Table 5). The rice cultivar Giza 177 obtained the highest percentage of head rice (66.57 and 64.76%) followed by Sakha 102 rice cultivar (65.95 and 64.34%), while Giza 182 rice cultivar was the lowest head rice percentage (60.07 and 59.49%) in the two seasons, respectively.

These differences of studied milling recovery characters, which obtained among different rice cultivars, might be due to their genetic differences.

b. Zinc fertilization rate effects:

The data showed that varying zinc levels caused significant differences in hulling % as listed in Table (5). The highest percentage (80.86 and 80.38 %) was resulted at 100% of the recommended zinc fertilization rate in the two seasons. It is obviously that increasing zinc level might be improved grain filling processes at the caryopsis of the spikelets which caused heaviest brown rice and lightest hulls.

Further, Data in Table (5) revealed that the highest percentage of milling was realized by using the treatment of 100% of the recommended zinc rate. Zinc fertilization rate was significantly affecting the milling in both seasons. It is note that milling percentage increase gradually from control to 100% of the recommended zinc fertilization rate then decreased to (70.23 and 70.16 %) by applying

150 % of the recommended zinc fertilization rate. The effect of zinc fertilization in milling percentage (%) may be due to improving growth, photosynthetic; net assimilates and grain filling as a result to the reduction in husk percentage.

Moreover, the results regarding head rice percentage as affected by various zinc rates are presented in Table (5). Zinc fertilization rate was significantly affecting the head rice % in both seasons. Increasing zinc rate from 0 to 100% increased head rice % from (66.36 and 65.63%) 100% of the recommended zinc fertilization rate to (64.80 and 64.43%) by using 150% of the recommended zinc rate.

c. Interaction effects:

Table (5) cleared that interaction between cultivars and zinc fertilization rates was not significant effect in regarding to hulling percentage in the two seasons, but the opposite was true for milling% and head rice%. Meanwhile, Table (6) indicated the interaction between cultivars and zinc fertilization rates on milling percentage (%) was significant in both seasons. mean values of rice cultivars Sakha 102, Sakha 106 and Giza 178 in the first season, and Giza 178 and Giza 182 rice cultivars in the second season were not significantly differed when fertilize by 50% of the recommended zinc rate.

Table (5): Hulling (%), milling (%) and head rice (%) as affected by cultivar, zinc fertilization rate as well as their interactions during 2011 and 2012 seasons

Character	Hulling (%)		Milling (%)		Head rice (%)	
Season	2011	2012	2011	2012	2011	2012
Rice Cultivar (C):						
Hybrid 1	79.11	79.01	69.38	67.94	61.47	61.88
Sakha 102	80.89	80.23	71.58	70.04	65.95	64.34
Sakha 105	80.08	79.57	69.94	69.51	64.91	63.61
Sakha 106	80.46	80.07	69.51	68.96	65.17	64.30
Giza 177	81.07	80.26	71.87	70.86	66.57	64.76
Giza 178	78.54	78.40	68.88	69.14	62.33	61.78
Giza 179	79.94	79.50	70.17	69.98	63.04	61.86
Giza 182	78.56	78.42	68.09	67.60	60.07	59.49
F-test	*	*	*	*	*	*
LSD at 0.05	0.64	0.51	0.71	0.77	0.91	0.97
Zinc fertilization rate (Zn):						
0	78.68	78.30	68.27	67.26	60.09	58.60
50	79.49	79.20	69.81	68.84	63.51	62.35
100	80.86	80.38	71.40	70.75	66.36	65.63
150	80.28	79.85	70.23	70.16	64.80	64.43
F-test	*	*	*	*	*	*
LSD at 0.05	0.39	0.48	0.50	0.41	0.61	0.60
Interaction:						
C x Zn	NS	NS	*	*	*	*

* and NS indicate P < 0.05 and not significant, respectively.

Table (6): Milling percentage (%) as affected by cultivar x zinc fertilization rate interaction at 2011 and 2012 seasons

Zinc fertilization rate		Cultivar							
		Hybrid 1	Sakha 102	Sakha 105	Sakha 106	Giza 177	Giza 178	Giza 179	Giza 182
2011	0	67.29	70.26	68.56	67.37	69.82	68.45	68.56	65.82
	50	69.57	71.88	70.17	69.00	61.61	68.78	69.51	67.99
	100	70.76	72.68	71.17	71.73	74.03	69.47	71.62	69.75
	150	69.90	71.50	69.88	69.94	72.04	68.82	70.99	68.78
	LSD at 0.05	1.06							
2012	0	65.57	68.30	67.88	66.84	69.64	67.87	67.44	64.53
	50	67.72	69.39	68.96	68.56	70.32	68.86	69.00	67.96
	100	69.56	71.19	71.55	70.73	72.36	69.72	71.89	69.02
	150	68.89	71.29	69.67	69.70	71.13	70.13	71.59	68.89
	LSD at 0.05	1.10							

On the other hand, the interaction between rice cultivars and zinc fertilization rates treatments on head rice percentage was significant in both seasons. Hybrid 1 in the second season can be used without effect of head rice %, when it fertilized by 50% of the recommended rate (Table, 7).

Table (7): Head rice percentage (%) as affected by cultivar x zinc fertilization rate interaction in 2011 and 2012 seasons

Zinc fertilization rate		Cultivar							
		Hybrid 1	Sakha 102	Sakha 105	Sakha 106	Giza 177	Giza 178	Giza 179	Giza 182
2011	0	60.00	58.68	62.52	61.23	63.50	58.94	59.26	56.57
	50	60.80	66.58	64.73	65.08	66.31	62.03	62.28	60.27
	100	63.14	69.65	66.48	67.29	68.83	65.43	66.49	63.59
	150	61.96	68.88	65.92	67.07	67.66	62.92	64.13	59.85
	LSD at 0.05	1.63							
2012	0	58.66	57.97	60.20	59.55	60.00	58.22	58.22	56.04
	50	61.41	64.92	63.00	62.76	64.28	61.78	61.33	59.33
	100	62.50	68.73	65.82	66.80	68.20	64.96	65.44	62.60
	150	64.96	65.77	65.44	68.08	66.57	62.17	62.47	60.01
	LSD at 0.05	1.74							

3. Cooking and eating characters effects:

a. Cultivar effects:

The behavior of rice cultivars significantly differed in gelatinization temperature (GT) in both seasons (Table 8); whereas, Giza 182 rice cultivar gave the highest values of gelatinization

temperature; while, Hybrid 1 resulted the lowest gelatinization temperature.

Table (8): Gelatinization temperature (GT), kernel elongation (%) and amylase content (%) as affected by cultivar, zinc fertilization rate as well as their interactions during 2011 and 2012 seasons

Character	Gelatinization temperature (GT)		Kernel elongation (%)		Amylose content (%)	
Season	2011	2012	2011	2012	2011	2012
Rice Cultivar (C):						
Hybrid 1	5.50	5.83	37.96	37.49	22.86	23.11
Sakha 102	6.41	6.16	39.53	38.64	19.83	19.08
Sakha 105	6.66	6.50	42.01	40.75	19.12	18.20
Sakha 106	6.58	6.33	38.08	37.61	19.31	18.93
Giza 177	6.41	6.16	38.18	38.05	18.79	17.96
Giza 178	6.66	6.41	40.15	40.15	19.68	18.97
Giza 179	6.58	6.16	37.55	36.55	19.27	18.67
Giza 182	7.00	6.58	36.16	36.08	20.63	19.33
F-test	*	NS	*	*	*	*
LSD at 0.05		-	0.95	0.87	0.67	0.65
Zinc fertilization rate (Zn):						
0	6.50	6.25	39.84	38.83	20.30	19.13
50	6.50	6.20	39.59	38.40	20.07	19.58
100	6.33	6.41	38.56	37.73	19.59	19.22
150	6.58	2.20	36.82	37.71	19.79	19.21
F-test	NS	NS	*	*	*	NS
LSD at 0.05	-	-	0.69	0.28	0.22	-
Interaction:						
C x Zn	NS	NS	*	*	*	*

* and NS indicate $P < 0.05$ and not significant, respectively.

In addition, data presented in Table (8) showed that rice cultivars significantly varied in their kernel elongation during the two seasons. Sakha 105 rice cultivar produced the highest percentage of kernel elongation, while the lowest kernel elongation percentage was obtained by Giza 182 rice cultivar in both seasons. From another side, amylose content percentage was significantly differed among rice cultivars during the two seasons. Hybrid 1 rice cultivar produced the highest percentage (22.86% and 23.11%) of amylose content (%), while the lowest one (18.79% and 17.96%) were obtained by Giza 177 rice cultivar in the two seasons. This varietal variation estimated for all cooking and eating quality characters might be due to their differences in their genetic makeup.

b. Zinc fertilization rate effects:

The results showed that insignificant effect on GT at various levels of zinc in both seasons were obtained in (Table 8). While,

analysis of variance indicated clearly that there was a significant difference in kernel elongation % (Table 8). The highest percentage of kernel elongation was obtained without zinc fertilization applied, while the lowest percentage obtained by 150% of the recommended zinc fertilization rate in the two seasons. Different results were reported by **Hasnain and Ali (2013)**, they found that increasing rate of zinc application significantly and linearly increased kernel elongation ratio compared to control.

From another point of view, the analysis of variance of the data revealed that varying zinc rates caused significant differences only in the first season in amylose content (%) as listed in Table (8).

The highest mean values of amylose content (%) were recorded at zero zinc fertilization (control). While, the lowest one was found for the (100% of the recommended zinc fertilization rate) treatment in the first season only. These findings are in contrary with **Hasnain and Ali (2013),** they found that amylose content was significantly and linearly increased with increasing zinc application rates.

c. Interaction effects:

It is worthy to note that the interaction between cultivars and zinc fertilizer was not significant in both seasons of study in case of gelatinization temperature, however, this interaction was significant regarding kernel elongation % in the two seasons (Table, 98). In 2011 season, there were insignificant differences between the mean values of kernel elongation (%) at 50% and 100% of the zinc levels regarding Giza 179 and Giza 182 rice cultivars. While in 2012 season the same results were obtained for Hybrid 1, Giza 177, Giza 178 and Giza 182 rice entries, indicating that this character will not be affected by applying 50% of the recommended zinc fertilizer (Table 9).

Table (9): Kernel elongation (%) as affected by cultivar x zinc fertilization rate interaction in 2011 and 2012 seasons

Zinc fertilization rate		Cultivar							
		Hybrid 1	Sakha 102	Sakha 105	Sakha 106	Giza 177	Giza 178	Giza 179	Giza 182
2011	0	38.44	40.52	47.92	36.08	39.40	42.97	35.55	37.82
	50	36.74	44.75	42.92	38.57	35.94	37.29	36.65	35.65
	100	40.80	37.70	40.32	41.47	39.36	43.50	37.97	35.62
	150	35.85	35.17	36.87	36.22	38.05	36.86	40.05	35.55
	LSD at 0.05	1.57							
2012	0	37.26	44.55	43.00	31.93	39.43	38.85	35.65	39.98
	50	38.38	41.41	40.78	40.10	36.86	38.41	35.84	35.45
	100	39.35	39.61	37.91	37.14	36.71	38.93	36.94	35.24
	150	35.44	37.42	38.93	35.14	39.23	38.39	41.55	35.56
	LSD at 0.05	1.67							

On the other hand, the effect of the interaction between rice cultivars and zinc fertilization rates treatments on amylose content (%) was significant in 2011 and 2012 seasons. Table (10). Looking to the effect of decreasing the zinc level from the recommended to 50%, the mean values of amylose content were not changed significantly in case of Sakha 102 and Sakha 105 rice cultivars in 2011 season, and for all rice cultivars except Sakha 102 rice cultivar in 2012 season.

Table (10): Amylose content (%) as affected by cultivar x zinc fertilization rate interaction in 2011 and 2012 seasons

Zinc fertilization rate		Cultivar							
		Hybrid 1	Sakha 102	Sakha 105	Sakha 106	Giza 177	Giza 178	Giza 179	Giza 182
2011	0	23.91	20.75	18.97	19.38	18.21	19.94	19.85	21.35
	50	23.10	19.91	19.35	19.85	18.00	18.57	20.00	21.79
	100	21.61	19.91	19.12	18.25	19.94	20.23	18.03	19.63
	150	22.83	18.75	19.03	19.79	19.01	19.98	19.23	19.75
	LSD at 0.05	1.41							
2012	0	23.57	20.25	18.50	16.71	17.93	18.75	18.81	18.53
	50	23.19	21.06	19.22	19.06	18.41	18.43	18.25	19.02
	100	23.47	17.93	19.03	19.72	19.78	17.21	17.46	19.12
	150	22.22	18.09	17.96	20.83	19.59	17.43	18.31	19.21
	LSD at 0.05	1.76							

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دراسـة تأثير مستويات مختلفه من التسميد بالزنك على صفات جودة الحبوب فى الأرز

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تم إجراء تجربة حقلية لدراسة تأثير مستويات مختلفه من التسميد بالزنك على صفات جودة الحبوب فى الأرز بالمزرعه البحثية بمركز البحوث والتدريب فى الارز (RRTC) , سخا , كفر الشيخ , مصر خلال موسمي الزراعة 2011و 2012 . وقد اشتملت المعاملات على سبعة أصناف من الأرز (سخا 102، سخا 105، سخا 106، جيزه 177، جيزه 178، جيزه 179و جيزه 182 بالإضافة إلى هجين1) وكذلك أربعة مستويات للتسميد بعنصر الزنك صفر، 50%، 100% و 150% من المعدل الموصى به من التسميد بالزنك (10 كجم كبريتات زنك/ فدان).

أوضحت النتائج المتحصل عليها وجود إختلافات معنوية بين جميع الأصناف تحت الدراسة لكل الصفات المدروسة وهذه الإختلافات كانت متوقعة نتيجة لاختلافات الوراثة بين الأصناف.

وقد أظهرت زيادة مستوى التسميد بالزنك إلى 150% من المعدل الموصى به تأثيرا على كل الصفات المدروسة والتى تشمل على صفات الجوده التى تشمل صفات أبعاد الحبة, صفات عملية التبييض و صفات جودة الطبخ و الأكل وكان هذا التأثير موجودا بكلا موسمى الدراسة.

وقد دلت النتائج المتحصل عليها أن التفاعل بين كل من أصناف الأرز ومستويات الزنك كانت معنوية فى معظم الحالات فيما عدا شكل الحبه, النسبه المئويه لتصافى التقشير و درجه حراره الجلتنه بكلا موسمى الدراسه.

كما أوضحت النتائج المتحصل عليها أيضا أنه فى كثير من الحالات كانت الإختلافات للصفات المدروسة غير معنوية بين معدل التسميد بعنصر الزنك الموصى به و 50% منه, وهذا يدل على أن الصنف جيزه 178 متبوعا بالصنف سخا 105 و سخا 106 تتأثر بنقص مستوى الزنك, ويمكن الإستفاده من هذه الأصناف فى برامج التربية للمدخلات المنخفضة.