Response of Local rice cultivar to Zinc and Boron application

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Abstract:

Five levels of Zn-EDTA fertilizer and foliar application of boron were used to study the local rice response through studying of some vegetative and reproductive growth characters, by conducting two field experiments at Kanipanka Agricultural Research Station during the summer season of 2004 by using RCBD with three replications. Significant differences were found in studied characters, there were increase in the number of days from seeding to 50% flowering (94.330-96.233) days, from 50% flowering to physiological maturity (37.50-38.28) days, plant height (82.50-91.423) cm and LAI (5.441-7.525). Reproductive characters such as number of grains panicle^{-1} (74.11-85.88), number of panicles m^{-2} (321.00-426.083), biological yield (8166.166-11082.600) kg ha^{-1} and yield which increased from 3101.333 to 3862.166 kg ha^{-1} as Zn level increased from f_o to f_5, but in exp. No 2 although final yield increased from 3100.333 to 3791.500 kg ha^{-1}, but there was increasing in sterility% from 15 for f_o to 27 for f_5 with boron foliar application. Results of the study indicate to positive response of local rice cultivars to zinc application due to the lack in zinc availability in sulaimani region.

Key words EDTA, Zn, B, local rice

Introduction:

The essential elements (including major elements) are needed and must be presented in the soils in optimum amounts and in available forms to rice plant [1]. Zn deficiency is more common under the conditions of high pH, calcareous, light and sandy soils, high phosphorous levels, and wet soils, availability of Zn in the soils correlated negatively with soil pH and $CaCO_3$ content and positively with clay content [2]. Crops under these soil conditions may suffer from zinc deficiency. Zn is essential for several metabolic processes in the rice plant, such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation, and membrane integrity [3]. The results of [4] indicated that Zn deficiency decreases leaf photosynthetic capacity primarily by reducing the number of PSII units per unit leaf area, and also reducing the photochemical capacity of the remaining PSII units. [5] studies indicated that under severe Zn deficiencies, tillering decreases or could stop completely, and time to crop maturity was extended, with spikelet sterility in rice increased. The critical range of zinc in soil differs according to soil and plant height. Zinc available for plant in different Iraqi soils ranged between 0.4-3.0 mg kg^{-1} soil [6, 7, 8]. Zn may be present in the soil, but not available to plants. The chemical analysis of the soils of

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Kurdistan region done by FAO has shown Zn deficiency in the soils of Sulaimani, Dohok and Erbil [9].

It was found that cereal crops respond to Zn application, which cause increase in dry matter yield in calcareous soils [10,11]. There were increases in grain yield and straw yield with Zn application [12,13,14]. The results obtained by [15] indicted that applied $ZnSO_4$ seems to be appropriate and useful to get more paddy yield with better quality kernels, number of panicle bearing tillers, number of spikelets per panicle, 1000 grain weight(g), paddy and straw yields, and sterility%. Due to the nature of most Iraqi soils which contain (10-35%) lime, and with pH above 7.0 most plants are expected to respond to zinc application [16]. Zinc deficiencies are most commonly corrected by application of the zinc fertilizer to the soil, zinc chelates are organic sources of zinc in which the zinc ions are protected by a claw-like chemical ring, this reduces the possibility of zinc being tied-up with phosphates and carbonates in the soils [3].

Boron like Zn is a micronutrient necessary for plant growth; it regulates transport of sugars through membranes, cell division, cell development, and auxin metabolism. Boron deficiency is wide spread in many Asian countries, it is more common in volcanic soils and calcareous soil, in annual crops, a common result of Boron deficiency in all crops is interruption in flowering, fruiting and the 50% decrease in yield may, rice sterility% may related in part to micro nutrient efficiency especially B availability in case of calcareous nature and high pH of the local soil. Foliar applications may sometimes be more effective than applying boron to the soil, foliar sprays of borax of only 50g ha^{-1} at the strategic times of flower development and pod set, were as effective method in correcting boron deficiency [17].

The aim of the present study is improving the production and yield of local rice cultivar, since it suffers from low level production and limited apportunity of water source and horizontal expanding.

Materials and Methods:

This study was conducted during summer season of 2004 at Kanypanka Agricultural Station (580 masl 35º22´37" N 45º43´33" E) by implementing two different experiments. The experiments were set up as R.C.B.D using local rice cultivar (Banixellan) and five rates of Zn-EDTA (0, 12, 24, 36, 48 kg Zn ha^{-1}, with three replications, The second experiment included zinc levels and the foliar application of 50 g ha^{-1} borax at the beginning of flowering stage., some soil physical and chemical analysis were conducted shown in table (1). Agricultural processes included two opposite direction cultivation, as well as land smoothing and leveling, the plots were sown with seeding rate of 120 kg ha^{-1} by direct seeding and 80 kg ha^{-1} Nitrogen fertilizer as ammonium sulphate which splitted to three applications and 40 kg ha^{-1} P_2O_5 applicated with cultivation process. Irrigation system was conducted and controlled in order to preventing mixing of Zn levels. Weekly measurements were done from seeding to physiological maturity, which included Plant height, days to 50% flowering, days from 50% flowering to physiological maturity, number of grains $panicle^{-1}$, number of $panicles\ plant^{-1}$, weight of 1000grains (g), biological yield and grain yield.

Table (1) some physical and chemical properties of the studied soil.

PSD g kg^{-1}			Textural class	Soluble ions (mmol L^{-1})						
Sand	Silt	Clay		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
34	549	417	SiC	0.98	0.41	0.39	0.03	3.1	0.43	0.9
pH	EC_e dS m^{-1}	CEC *cmolc kg^{-1}	O.M	$CaCO_3$	equivalent	Exchangeable cations				
				Total	active	Cmol kg^{-1}				
7.75	0.28	49.77	gm kg^{-1}			Ca_{ex}	Mg_{ex}	K_{ex}	Na_{ex}	
			21	240	100	41.5	1.2	0.44	0.16	

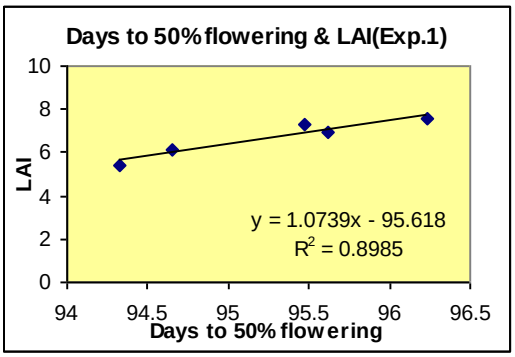
*$cmol_c$ kg^{-1} = meq/100g soil

Results and Discussions:

Table (2) indicated that zinc fertilizer application significantly increased the number of days from seeding to 50% flowering, days from 50% flowering to physiological maturity, plant height, and LAI. With increasing zinc fertilizer rates days to 50% flowering increased from 94.330 to 96.233 days in experiment 1, in Exp.2 such increase refers to positive response of local rice cultivar to zinc application and indicates to the lack of Zn availability, these results agree with results of [16]. Fig.1 and 2 show highly correlation (r^2 =0.89 and 0.96) between the length of vegetative growth and leaf area expanding Exp.1from 5.441 to 7.551 in experiment 1 and from 5.46 to 7.32 in Exp.2

Table (2) Effect of different rate of Zn fertilizers applied to the soil on some agronomic traits of rice.

No. of exp.	kg Zn ha^{-1}	Days to 50% flowering	Days from 50% flowering to PM	plant height cm	LAI
Zn exp.1	0	94.330	37.50	82.500	5.441
	12	94.650	37.43	87.33	6.163
	24	95.616	37.38	87.916	6.968
	36	95.469	37.86	89.833	7.330
	48	96.233	38.28	91.423	7.525
Zn+B exp.2	0	96.383	38.15	86.666	5.460
	12+B	96.383	39.01	87.666	5.860
	24+B	97.016	39,41	89.833	7.070
	36+B	97.300	40.43	92.166	7.360
	48+B	97.250	42.28	92.750	7.320



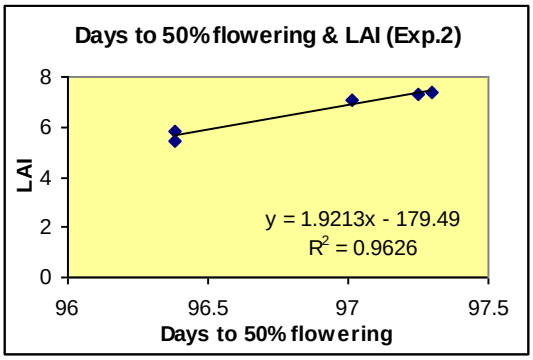


Fig.(1,2)Relationship between LAI and Number of days to 50%flowering.

LAI indicates to the area exposed to sun light, which directly affect photosynthesis rate due to its direct effect on chlorophyll synthesis [4], this is closely related to dry matter accumulation per unit area, it means that final yield depends upon photosynthesis efficiency and the area exposured for photosynthesis [18]. In addition to that, it is considered as a second active source for the grain filling stage because the net products

of photsynthesis which are synthesized during reproductive growth is used for grain yield by plants[18, 19].

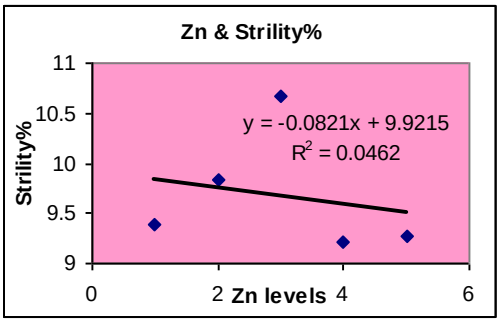
Table (3) represents the significant difference in agronomic traits including, no.of grains panicle^{-1}, no.of panicle m^{-2}, sterility%, biological yield, and kernel yield. No significant difference observed in 1000 grain weight [20] reported the same results in rice. No.of grains panicle^{-1} increased from 74.11 to 85.88 as the Zn level rised from 0 to 48 kg ha^{-1}, and maximum number of panicles m^{-2} was recorded by 36kg ha^{-1} which did not differ significantly from 48 kg ha^{-1}, while 48 kg ha^{-1} treatment recorded minimum percentage of sterility (9.275%). The maximum biological yield and final yield were recorded by 48 kg ha^{-1} treatment which was 11082.5 and 3862.5 kg ha^{-1} respectively, similar results recorded by [20]. Increasing the rate of Zn application correlated with agronomic traits related to the efficiency of physiological processes in the rice plants [15, 16, and 20]. Table (4) indicates to similar increase in yield characters due to Zn and B treatments, with the exception of sterility%. There was an increase in its mean due to rising of fertilizer application from 0.15 to 0.27 and maximum rate was recorded from f_3 which was 0.33, that may be caused by the effect of Boron and cultivar sensitivity to B application, and the result agreed with [17].

Table (3) effect of different rate of Zn fertilizers applied to the soil onyield characters.

Zn levels	No.of grain panicle^{-1}	No. of panicle m^{-2}	Wt of 1000grain g	Sterility %	Biological yield kg ha^{-1}	Yield kg ha^{-1}
f_o	74.11	321.000	26.64	9.380	8166.166	3101.333
f_1	77.72	363.416	26.78	9.833	8580.333	3361.000
f_2	81.11	378.166	27.06	10.666	9055.333	3590.000
f_3	82.83	428.583	27.10	9.222	9687.000	3828.500
f_4	85.88	426.083	27.15	9.275	11082.500	3862.166

Table (4) Effect of different rate of Zn and B fertilizers applied to the soil on yield characters.

B levels	No.of grain panicle^{-1}	No. of panicle m^{-2}	Wt of 1000grain g	Sterility %	Biological yield kg ha^{-1}	Yield kg ha^{-1}
B f_o	75.803	328.333	26.7	0.15	9022	3100.333
B f_1	78.886	402.666	26.68	0.14	9573.833	3250
B f_2	80.691	402.333	26.67	0.29	10290	3541
B f_3	83.826	434.666	27.06	0.33	10946	3701.5
B f_4	87.496	430.5	27.17	0.27	11720.67	3791.5



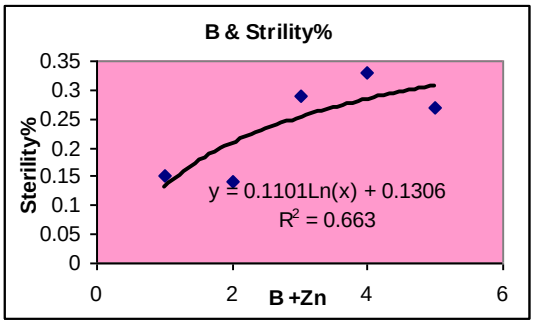


Fig.(4,5) The relationship between Sterility% and Zn levels(exp.no1)L,

The relationship between Sterility% and Zn levels +B (exp.no2)R

Table (5) Comparison between agronomic traits and yield characters studied in Exp.1 and Exp.2

No. of exp.	No.of grain panicle^{-1}	No. of panicle m^{-2}	Wt of 1000 grains g	Sterility%	Biological yield kg ha^{-1}	Yield kg ha^{-1}	Days to 50% flowering	from 50% flowering	plant height cm	LAI
Exp.1	401.65	383.449	26.946	11.072	9314.266	3557.2	95.257	37.690	87.7	6.685
Exp.2	406.68	399.696	26.856	17.685	10310.57	3476.9	96.938	39.856	89.81	6.614
LSD $_{0.05}$	3.163	2.416	NS	6.274	5.778	1.372	4.262	3.159	2.439	NS

Results of table (5) indicated to significant differences between Exp.1 and Exp.2, in both the vegetative and reproductive characters, with exception in the 1000 grains weight and LAI. In relation to Exp.2, there was an increasing in the number of days to 50% flowering, No. of days from 50% flowering to physiological maturity, plant height that caused increase in biological yield, as well as number of panicle m^{-1} indicating to increasing in number of tillers, all these increases were associated with increasing Sterility% from 11.072 to 17.685. According to higher percentage of sterility in Exp.2, and in spite of increasing number of panicle.m^{-2} and No. of grains panicle^{-1}, the final yield as shown from table (5) and figs.(6,7) was higher in exp.1 (3557.2kg ha^{-1}) than Exp.2(3476.866 kg ha^{-1}), that was similar to results of [17].

Conclusions:

There were significant differences in the studied vegetative and reproductive growth characters due to zinc fertilizer application, indicating to the positive response of local rice cultivar and the lack in availability of the zinc element in Sulaimani soil, but the results of Exp.no.2 showed increasing in sterility% with boron foliar application.

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استجابة الرز المحلي لاضافات من الزنك و البورون

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الخلاصة:

تم استخدام خمسة مستويات مختلفة من سماد الزنك المخلبي مع رشة مضافة من البورون بهدف دراسة و استجابة الرز المحلي عن طريق دراسة بعض صفات النمو الخضري و النمو الثمري و ذلك بتطبيق تجربتين حقليتين في موقع كانيبانكة خلال موسم الصيف 2004 باستخدام تصميم القطع العشوائية الكاملة و بثلاثة مكررات, تم الحصول على اختلافات معنوية في الصفات المدروسة في عدد الايام من الزراعة الى 50% تزهير من (96,33-94,33) يوم, و من 50% تزهير الى النضج الفسلجي من (58,28-37,50)يوم ,و ارتفاع النبات من (91,423-82,5)سم و دليل المساحة الورقية من (7,525 – 5,441), و صفات النمو الثمري مثل عدد الحبوب في الدالية (85,18-74,11)حبة/ دالية, عدد الداليات/ م^2 (426,083=321)دالية/ م^2 ,الحاصل البايولوجي من(11082,6 -8166,166)كغم/ هكتار , و الحاصل النهائي من(3862,166 -3101,333) كغم/ هكتار, مع ارتفاع مستويات الزنك المضافة, اما بالنسبة الى التجربة الثانية فبالرغم من ارتفاع معنوي في الحاصل النهائي من 3100,333 الى 3791,500 كغم/ هكتار و لكن هناك ارتفاع في النسبة المئوية لعدم الخصب من 15% الى 27%, النتائج تؤشر الى استجابة موجبة للرز المحلي لاضافة السماد الزنك المخلبي والى نقص في جاهزية عنصر الزنك في ترب منطقة السليمانية.