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Response of Rice Yield, Its Components and Quality to Silicon and Boron Foliar Application

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ABSTRACT

At the Experimental Station of Faculty of Agriculture, Ain Shams University at Shalakan, Kalubia Governorate, Egypt, a field experiment was conducted during 2014 and 2015 growing seasons to investigate the effect of foliar application of silicon and boron on sakha 104 rice cultivar yield, yield components and grain quality. The experiment included 16 treatments which were the combinations of four Si rates (0, 1000, 2000 and 3000 ppm Si as silica fume 98% Si) and four B rates (0, 30, 60 and 90 ppm B, as boric acid 11.17% B). In a split plot design with three replications, Si treatments occupied the main plots and B ones distributed in the sub plots. Application of 3000 ppm Si gave the highest values of panicle weight and filled grains %. Spraying 3000 ppm Si along with 2000 ppm Si recorded the highest panicle number/m^2, panicle length and filled grains number per panicle. Except for 0 ppm Si treatment, all other applied Si rates statistically equaled in spikelets numbers/panicle and 1000 grain weight. Thus, plots received 3000 ppm Si exhibited increases 13.4, 13.3, 13.4 and 19.0% in grain, straw, biological and grain crude protein yields, respectively, compared to the control (without Si). Rice plants fertilized with 90 ppm B possessed the maximal yields surpassing other studied rates. Such treatment out yielded increases of 15.8 in grain yield, 14.1% in straw yield, 14.8% in biological yield and 23.5% in crude protein yield over the control (0 ppm B). The high performance of rice plants with 3000 ppm Si and 90 ppm B application in yield attributes was reflected on its yield parameters. The maximal values of grain (4372.33 kg/fad), biological (9310.00 kg/fad) and GCP yields (359.11 kg/fad) were obtained when rice plants foliar application with 3000 ppm Si + 90 ppm B. As a general trend, coupling high concentrations of Si with B caused the best impact on GCP, GNY, TNY, NRE and NUE where 3000 ppm Si x 90 ppm B was the effective combination in this respect.

Key words: Rice; *Oryzae sativa,* L., silicon, boron, foliar application, yield attributes, nitrogen efficiency

Introduction

Rice (*Oryzae sativa*, L.) is a standout amongst the most critical grain trims in Egypt and assumes an imperative part in the methodology to defeat nourishment deficiency and enhance independence. It is developed in Egypt on a region of 1.216 million faddan with a yearly creation of around 4.82 million tones and with a normal yield of 3.96 tons for each faddan amid the year 2015 developing season (CLAC, 2015). Micronutrients, for example, silicon and boron are imperative for maintainable of rice. Physiologically, boron inadequacy may bring about loss of honesty and capacity of layer, and diminishing in cell divider dependability coming about auxiliary harm in plants (Cakmak and Romheld, 1997 and Blevins and Lukaszewski, 1998). In like manner, boron lack influences digestion systems of nucleic corrosive, sugar, protein, indole acidic corrosive and phenolics (Cakmak and Römheld, 1997). Boron application to rice fields expanded rice development and grain yields in soils low in boron (Rashid *et al.,* 2009 and Hussain *et al.,* 2012); in any case, a few issues with take-up of boron in states of diminishing boron in soil boron lack side effects have been discovered (Dunn *et al.,* 2005). Despite the fact that foliage connected boron enhances the grain yield of rice (Dunn *et al.,* 2005 and Hussain *et al.,* 2012), it was theorized that boron foliar connected can meet the boron prerequisite of rice and enhances grain yield, by diminishing the panicle sterility. Dobermann and Fairhurst (2000) delighted that insufficiency of boron in rice additionally brought about hindered development and decrease in the quantity of panicles. Under such conditions, foliar treatment is more

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successful and practical. Liew *et al*., (2012) found that rice yield parts, for example, gainful tiller/m2, number of spikelets/panicle, level of filled grains and 1000-grain weight have additionally indicated noteworthy augmentations because of the boron foliar treatment. Utilization of boron had not demonstrated any expansion in plant stature, though 1000-grain weight, paddy yield collect record and every quality parameter were essentially influenced by boron at 1.0% boron arrangement (Awais *et al*., 2012).

Silicon is a vital micronutrient for solid and focused development of all grains including rice (Brunings *et al.,* 2009). Part of silicon in plant wellbeing and development has been examined in silicon gathering yields and it appeared to be fundamentally affecting (Jinab *et al.,* 2008). Research confirmations demonstrated that satisfactory take-up of silicon (Si) can expand the resilience of agronomic yields particularly rice to both abiotic and biotic anxiety and it has been accounted for to moderate the aluminum (Al) and iron (Fe) lethality and an extensive variety of worries in rice and different harvests (Ma and Takahashi, 2002). Micronutrients, for example, silicon are the most critical for feasible creation of Basmati rice. In spite of the fact that the dissolvability of silicate minerals shift under various soil and ecological conditions however its focuses in soil arrangements run from 0.1 to 0.6 mM typically (Ahmad *et al.*, 2013). Numerous researchers dealing with part of silicon in plant development have presumed that diminished measure of silicon in plant creates rot, aggravation in leaf photosynthetic proficiency, development hindrance and decreases grain yield in oats (Shashidhar *et al.,* 2008). Silicon (1.0% silicon level) created the greatest plant stature and grain starch where in all others parameters silicon at 1.5% silicon arrangement came about best. (Awais *et al.,* 2012).

Consolidate utilization of both the supplements at 1.5% silicon and 1.0% boron performed well. The intelligent impact of silicon at 1.5% and boron at 1% has essentially enhanced 1000 pieces weight (19.65 g), natural yield (20.09 t for every ha), portion yield (5.63 t for each ha), protein content (7.23 %), starch content (79.71 %) and prudent to utilize. (Awais *et al.,* 2012). In the light of above talks, display consider was intended to research the impact of foliar use of various groupings of silicon and boron on fine rice under the agro states of Egypt. The fundamental goal was to assess the impact of foliar use of silicon and boron on yield and nature of rice.

Material and Methods

Procedures

At the Experimental Station of Faculty of Agriculture, Ain Shams University at Shalakan, Kalubia Governorate, Egypt, a field experiment was conducted during 2014 and 2015 growing seasons to investigate the effect of foliar application of silicon and boron on sakha 104 rice cultivar yield, yield components and grain quality. The soil of the experimental site was clay and its constituents and properties estimated according to Black (1965) and Jackson (1967) are presented in Table (1). The experiment included 16 treatments which were the combinations of four Si rates (0, 1000, 2000 and 3000 ppm Si as silica fume 98% Si) and four B rates (0, 30, 60 and 90 ppm B, as boric acid 11.17% B). Using backpack sprayer with nozzles oriented vertical spraying of 200 l/fad, the treatments were applied three times (45, 60 and 75 days after sowing, DAS). In a split plot design with three replications, Si treatments occupied the main plots and B ones distributed in the sub plots. The experimental unit size was 16 m^2 (4m×4m). Rice grains at a rate of 50 kg/fad. were soaked in water for 24 hours, then drained and incubated for 48 hours to enhance germination. Per-germination seeds were manually broadcasted on 1^{st} May in both seasons. In wet leveled plots, 30 day old seedlings were manually transplanted at 20cm×20 cm spacing between rows and hills for obtaining 25 hills/m^2. All other agronomic practices were uniformly applied as recommended.

Recorded data

At harvest (140 DAS), a sample of plants from one square meter of each experimental unit was collected at random for measuring panicle no/m^2, panicle length (cm), spikelets/panicle, panicle weight (g), filled grain %, filled grain no/panicle, 1000 grain weight (g), grain yield (kg/fad), straw yield (kg/fad), biological yield (kg/fad), and harvest index (HI%). Moreover, according to AOAC (1995), about 50g of grains were fine grinded to determine nitrogen (N) percentage using microKjeldal method. The grain crude protein content (GCPC) was calculated by multiplying total N% by 5.7, then the grain crude protein yield (GCPY) was computed. The soluble carbohydrate% was determined by acid hydrolysis.

The accumulated total nitrogen in grains and straw yields were estimated according to AOAC (1995) to calculate nitrogen physiological parameters including N recovery efficiency (NRE, kg N absorbed*100/kg N applied/fad), N use efficiency (NUE, grain yield in kg/fad/kg N applied/fad), nitrogen harvest index (NHI, total N in grains*100/total N uptake) and nitrogen physiological efficiency (NPE, grain yield in kg/fad/N absorbed/fad) were calculated according to Timsina *et al* (2001).

Table 1: Soil mechanical and chemical analysis of experimental site at Shalakan

Mechanical constituents %			Chemical properties							
Fine sand	Silt	Clay	Total N	pH	Soluble anions and cations (meq/l)					
			(ppm)		HCO_3^-	Cl^-	Ca^{++}	Mg^{++}	Na^+	K^+
11	31	58	1200	8.0	54.7	44.7	52.6	13.9	38.9	12.7

Statistical analysis:

Obtained data were exposed to the proper statistical analysis according to Snedecor and Cochran (1967). Using Costat computer program V 6.303 (2004), the least significant differences (LSD) at 5% level of significance was used to differentiate between means. Data of 2014 and 2015 growing seasons were subjected to homogeneity variance test for running the combined analysis.

Results and Discussion

1. Rice yield components

1.1. Effect of Si

Analysis of variance indicated clearly that yield components of rice were significantly affected by silicon foliar application (Table 2). Generally, panicle number/m^2, panicle length, spikelets numbers/panicle, panicle weight, filled grains %, filled grains number per panicle and 1000 grain weight of rice were increased with increasing Si concentration. In this regard, foliar application of 3000 ppm Si gave the highest values of panicle weight and filled grains %. Spraying 3000 ppm Si along with 2000 ppm Si recorded the highest panicle number/m^2, panicle length and filled grains number per panicle. Except for 0 ppm Si treatment, all other applied Si rates statistically equaled in spikelets numbers/panicle and 1000 grain weight. The significant enhancement of yield components as increasing silicon concentrations can be credited to its vital role in plant growth and development. Si has a vital role in enhancement cell elongation as a result of Si–enhanced extensibility of the cell in rice (Hossain *et al*., 2002) and promotion of K uptake (Liang *et al*., 1999). Gong *et al.* (2003) observed that Si increased plant height, leaf area and dry mass. These results are coincided with those reported by Shashidhar *et al*. (2008), Awais *et al*. (2012). and Ahmad *et. al*. (2013). Besides, Si plays an important role in reducing plants vulnerability to biotic and abiotic environmental stresses (Ma and Yamaji 2006).

1.2. Effect of B

As shown in Table 2, B concentrations had remarkable impacts on yield components of rice. B at a rate of 90 ppm was the potent practice for enhancing panicle number/m^2, panicle length, spikelets numbers/panicle, panicle weight, filled grains %, filled grains numbers per panicle and 1000 grain weight. However, such effective treatment was as similar as that of 60 ppm in panicle umber/m^2, panicle length, spikelets numbers/panicle, filled grains numbers per panicle and 1000 grain weight.as well as 30 ppm in 1000 grain weight. More number of grains per panicle and higher grain weight by B

Table 2: Effect of Si and B foliar application on yield components of rice (Combined analysis of 2014 and 2015 seasons).

Treatment		Panicles number/m^2	Panicle length (cm)	Spikelets /panicle	Panicle weight (g)	Filled grains %	Filled grains number/panicle.	1000-grain weight (g)
Silicon, Si (ppm)								
Si1,0		382.42	17.75	132.75	2.71	92.96	123.58	22.12
Si2, 1000		420.25	19.08	134.58	2.90	94.71	127.67	22.62
Si3, 2000		449.17	20.83	136.58	3.02	95.84	131.08	23.18
Si4, 3000		450.75	21.58	138.25	3.18	97.31	134.72	23.84
$LSD_{5\%}$		**8.23**	**0.97**	**4.31**	**0.10**	**0.85**	**4.70**	**1.26**
Boron, B (ppm)								
B1, 0		364.33	18.00	121.42	2.42	91.67	111.35	21.93
B2, 30		414.92	19.50	135.33	2.91	95.26	128.96	22.80
B2, 60		460.42	20.67	142.33	3.17	96.41	137.25	23.36
B4, 90		462.92	21.08	143.08	3.30	97.47	139.50	23.66
$LSD_{5\%}$		**6.00**	**0.79**	**3.36**	**0.11**	**0.92**	**3.30**	**0.87**
Si x B								
Si1	B1	327.67	16.67	118.33	2.20	89.86	106.33	21.08
	B2	377.00	17.33	131.67	2.60	92.91	122.33	21.80
	B3	411.33	18.33	140.00	2.93	93.81	131.33	22.68
	B4	413.67	18.67	141.00	3.10	95.27	134.33	22.92
Si2	B1	350.67	17.33	120.67	2.37	90.88	109.67	21.29
	B2	402.67	18.67	133.33	2.86	95.25	127.00	22.91
	B3	463.67	20.00	142.00	3.14	96.01	136.33	23.09
	B4	464.00	20.33	142.33	3.23	96.72	137.67	23.19
Si3	B1	388.67	18.67	122.00	2.48	92.35	112.67	22.39
	B2	439.67	20.33	137.67	3.01	95.64	131.67	22.91
	B3	483.00	22.00	143.00	3.20	96.97	138.67	23.44
	B4	485.33	22.33	143.67	3.36	98.38	141.33	23.98
Si4	B1	390.33	19.33	124.67	2.64	93.63	116.72	22.95
	B2	440.33	21.67	138.67	3.16	97.24	134.83	23.58
	B3	483.67	22.33	144.33	3.42	98.85	142.67	24.24
	B4	488.67	23.00	145.33	3.52	99.54	144.67	24.56
$LSD_{5\%}$		**12.01**	**1.58**	**6.72**	**0.23**	**1.84**	**6.60**	**1.74**

application might be due to involvement of B in reproductive growth being it improves the panicle fertility in rice (Rehman *et al*. 2014). The significant enhancement of yield components in order with increasing boron concentrations can be credited to higher dose of boron, which greatly helps the plant to expose its potential to grow potentially. These results are coincided with those reported by Awais *et al*. (2012). Boron assumes a critical part in quickening the arrangement of panicles in rice plants. Liew *et al.* (2012) announced that B inadequacy, especially at the panicle arrangement organize, would incredibly lessen the development of panicles and assume imperative parts in photosynthesis and breath, starch digestion and sugar transport in rice plant.

1.3. Effect of interaction between Si and B

Interaction between Si and B application had significantly effects on yield components of rice (Table 2). Application of 3000 ppm Si+90 ppm B exhibited maximum panicle number/m^2, panicle length, spikelets numbers/panicle, panicle weight, filled grains, filled grains numbers per panicle and 1000 grain weight.

2. Rice yields

2.1. Effect of Si

Rice plants treated with higher rates of Si not only produced higher yield attributes (Table 2) but also increase yields (Table 3). Thus, plots received 3000 ppm Si exhibited increases 13.4, 13.3, 13.4 and 19.0% in grain, straw, biological and grain crude protein yields, respectively, compared to the control (without Si). Application of 2000 ppm Si came in the second order surpassing lower Si rates in this respect. Enhancements in rice yields due to effective Si treatments may be attributed to their efficiency for promoting yield components, i.e. panicle number, weight and length and filled grains % (Table 2).

Table 3: Effect of Si and B foliar application on yields and harvest index (HI%) of rice (Combined analysis of 2014 and 2015 seasons).

Treatment		Yield kg / fad.				HI. %
		Grain	Straw	Biological	Grain crude protein	
Silicon, Si (ppm)						
Si1,0		3636.6	4154	7790.6	275.93	46.67
Si2, 1000		3787.9	4305.1	8093.0	290.3	46.8
Si3, 2000		4035.8	4561.6	8597.4	315.59	46.95
Si4, 3000		4125.6	4707.6	8833.2	328.23	46.69
$LSD_{5\%}$		**31.07**	**52.06**	**64.30**	**1.57**	**N.S**
Boron, B (ppm)						
B1, 0		3559.4	4092.8	7652.2	265.65	46.51
B2, 30		3823.8	4337.5	8161.3	292.85	46.85
B2, 60		4082.4	4630.1	8712.5	323.51	46.86
B4, 90		4120.3	4667.9	8788.3	328.04	46.88
$LSD_{5\%}$		**25.04**	**35.36**	**47.3**	**3.73**	**N.S**
Si x B						
Si1	B1	3331.00	3896.33	7227.33	242.39	46.09
	B2	3577.00	4051.67	7628.67	267.44	46.89
	B3	3795.67	4308.00	8103.67	295.30	46.84
	B4	3842.67	4360.00	8202.67	298.58	46.85
Si2	B1	3500.67	4000.33	7501.00	258.12	46.67
	B2	3747.33	4288.67	8036.00	285.55	46.63
	B3	3946.33	4450.33	8396.67	307.95	47.00
	B4	3957.33	4481.00	8438.33	309.60	46.90
Si3	B1	3637.33	4082.00	7719.33	274.13	47.12
	B2	3941.00	4450.67	8391.67	305.43	46.96
	B3	4256.00	4820.67	9076.67	337.93	46.89
	B4	4309.00	4893.00	9202.00	344.86	46.83
Si4	B1	3768.67	4392.33	8161.00	287.93	46.18
	B2	4029.67	4559.00	8588.67	312.97	46.92
	B3	4331.67	4941.33	9273.00	352.89	46.71
	B4	4372.33	4937.67	9310.00	359.11	46.96
$LSD_{5\%}$		**50.09**	**70.72**	**94.61**	**7.45**	**N.S**

Also, Si has an indirect effect for promoting dry matter accumulation by enhancing nutrients uptake. In this regard, Tahir *et al.* (2006) demonstrated that Si upgraded K/Na selectivity proportion improving dry issue and grain yield. Besides, Ma and Takahashi (1990) inferred that there is a high P take-up in rice with Si application which straightforwardly associates the expanded development and yield. Our outcomes are as per those of Shashidhar *et al.* (2008), Awais *et al.* (2012) and Ahmad *et al.*, (2013). On the other hand, harvest index was not affected by foliar applied Si. It means that increase grain yield was accompanied with increase of straw yield by the same trend.

2.2. Effect of B

Grain, straw, biological and grain crude protein yields markedly increased with increasing B rates (Table 3). Herein, rice plants fertilized with 90 ppm B possessed the maximal yields surpassing other studied rates. Such treatment out yielded increases of 15.8 in grain yield, 14.1% in straw yield, 14.8% in biological yield and 23.5% in CPY over the control (0 ppm B). These results refer to that the improvements in yield attributes due to increasing B rates (Table 2) may extended to affect yields. The vital role of B for enhancing rice productivity was reported by Awais *et al.* (2012) and Liew *et al*. (2012). On the contrary, B has no significant impact on HI.

B assumes a key part in starch digestion, sugar transport and dust reasonability in rice and boron has for some time been recognized as one of the real imperatives for grain trim creation on the planet. With regards to Liew *et al.* (2012) who recorded that B inadequacy as a confinement for accomplishing high return in real rice planting territories. Specifically, the use of B can improve grain creation essentially.

2.3. Effect of interaction between Si and B

The high performance of rice plants with 3000 ppm Si and 90 ppm B application in yield attributes was reflected on its yield parameters (Table 3). Data cleared that maximal values of grain (4372.33 kg/fad), biological (9310.00 kg/fad) and GCP yields (359.11 kg/fad) were obtained when rice plants foliar application with 3000 ppm Si + 90 ppm B. While, maximum value of straw (4941.33kg/fad.) was obtained when rice plants foliar application with 3000 ppm Si + 60 ppm B, these results are similar with Awais *et al.* (2012). Meanwhile, harvest index was slightly affected by interaction between Si and B application to be range between 46.09 to 47.12%. It means that increase grain yield was accompanied with increase of straw yield by the same trend.

3. N physiological parameters

Grain and straw nitrogen contents were estimated to evaluate nitrogen physiological parameters as affected by studied treatments of Si and B and their interaction as presented in Table (4).

3.1. Effect of Si

Distinctive variations in GCP, soluble carbohydrates as well as N physiological traits, i.e. GNY, SNY, TNY, NRE, NUE and NPE due to various Si rates were achieved, while NHI did not affect. In this regard, Table 4 shows that application of 3000 ppm silicon had the maximum values of GCP, GNY, SNY, TNY, NRE and NUE. Si at a rate of 2000 ppm showed the highest soluble carbohydrates and significantly equaled with 3000 ppm Si in SNY. On the other hand, NPE exhibiting maximum value in control treatment along with 1000 ppm Si one. These results resembled to the findings, that application of silicon improve the crop quality as reported by Shashidhar *et al.* (2008) and Ahmad *et al*., (2013). However, there is a lack of scientific studies and information on the effectiveness of such element and there is a dire need to be well identified.

Table 4: Effect of Si and B foliar application on grain crude protein (GCP%), soluble carbohydrate% and nitrogen physiological traits of rice (Combined analysis of 2014 and 2015 seasons).

Treatment		GCP %	Soluble Carbohydrates %	N physiological traits						
				GNY kg/fad	SNY kg/fad	TNY kg/fad	NRE %	NUE	NPE	NHI %
Silicon, Si (ppm)										
Si1,0		7.58	75.13	48.41	5.76	54.16	90.28	60.61	67.31	89.38
Si2, 1000		7.66	75.65	50.93	6.07	57.01	95.01	63.13	66.58	89.35
Si3, 2000		7.81	76.05	55.37	6.64	62.01	103.34	67.26	65.25	89.32
Si4, 3000		7.94	75.48	57.58	6.96	64.54	107.57	68.76	64.11	89.22
$LSD_{5\%}$		**0.06**	**0.45**	**0.28**	**0.36**	**0.53**	**0.89**	**0.52**	**0.73**	**N.S**
Boron, B (ppm)										
B1, 0		7.46	74.34	46.6	5.53	52.14	86.89	59.33	68.36	89.40
B2, 30		7.65	74.97	51.38	6.01	57.38	95.64	63.73	66.71	89.54
B2, 60		7.92	76.95	56.76	6.88	63.63	106.06	68.04	64.25	89.20
B4, 90		7.95	76.06	57.55	7.01	64.56	107.60	68.67	63.93	89.14
$LSD_{5\%}$		**0.07**	**0.38**	**0.65**	**0.24**	**0.70**	**1.17**	**0.42**	**0.56**	**N.S**
Interaction (Si x B)										
Si1	B1	7.28	73.74	42.52	5.07	47.59	79.32	55.52	70.00	89.36
	B2	7.48	74.51	46.92	5.40	52.32	87.20	59.62	68.37	89.67
	B3	7.78	76.89	51.81	6.17	57.98	96.64	63.26	65.46	89.35
	B4	7.77	75.40	52.38	6.39	58.78	97.96	64.04	65.38	89.12
Si2	B1	7.37	74.43	45.28	5.33	50.62	84.36	58.34	69.16	89.46
	B2	7.62	74.92	50.10	5.86	55.96	93.26	62.46	66.97	89.53
	B3	7.80	77.11	54.03	6.53	60.55	100.92	65.77	65.17	89.22
	B4	7.82	76.15	54.31	6.57	60.89	101.48	65.96	64.99	89.21
Si3	B1	7.54	74.97	48.09	5.58	53.67	89.45	60.62	67.77	89.61
	B2	7.75	75.26	53.58	6.23	59.81	99.69	65.68	65.89	89.58
	B3	7.94	77.29	59.29	7.23	66.52	110.86	70.93	63.98	89.13
	B4	8.00	76.69	60.50	7.50	68.00	113.34	71.82	63.36	88.97
Si4	B1	7.64	74.21	50.51	6.15	56.66	94.44	62.81	66.51	89.15
	B2	7.77	75.18	54.91	6.53	61.44	102.40	67.16	65.59	89.36
	B3	8.15	76.52	61.91	7.58	69.49	115.81	72.19	62.34	89.10
	B4	8.21	76.02	63.00	7.57	70.57	117.62	72.87	61.95	89.27
$LSD_{5\%}$		**0.14**	**0.76**	**1.31**	**0.48**	**1.41**	**2.34**	**0.83**	**1.12**	**N.S**

3.2. Effect of B

In spite of NHI, GCP, soluble carbohydrates as well as N physiological traits, i.e. GNY, SNY, TNY, NRE and NUE showed statistical differences as a result of treating with varied B levels (Table 4). The potent practice in this concern was spraying with 90 ppm B being recorded the maximum values of aforementioned traits. Moreover, the differences between 90 ppm B and 60 ppm B did not reach the 5% level of significance for GCP, soluble carbohydrates and SNY. Unlike, NPE gave the highest value when rice plants did not treat with B.

3.3. Effect of interaction between Si and B

As a general trend, coupling high concentrations of Si with B caused the best impact on GCP, GNY, TNY, NRE and NUE where 3000 ppm Si x 90 ppm B was the effective combination in this respect. Additionally, the treatment of 2000 ppm Si x 60 ppm B (for soluble carbohydrates) as well as that of 3000 ppm Si x 60 ppm B (for SN Y) recorded the maximum values (Table 4). Contrariwise, zero concentration of Si and B via 0 ppm Si x 0 ppm B gave the maximum NPE.

Conclusion

From the above results, it could be concluded that. Silicon, boron and their interaction application of 3000 ppm Si and 90 ppm B exhibited maximum panicle number/m^2, panicle length, spikelets numbers /panicle, panicle weight, filled grains%, filled grains numbers per panicle and 1000 grain weight. The high performance of rice plants with 3000 ppm Si and 90 ppm B application in yield attributes was reflected on its yield parameters: grain, biological and GCP yields.

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