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Two Iranian Rice Cultivars Responses to Nitrogen and Nano-Fertilizer

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Abstract: In order to investigate effect of nano potassium and nano silicon and nitrogen rate in two rice cultivars, an experiment was carried out as split factorial in randomized complete blocks design with three replications at Sari, Iran in 2013 and 2014. Rice cultivars were chosen as main plots including Tarom Mahalli and Tarom Hashemi. Nitrogen rates 34 and 69 kg N ha^{-1} and nitroxin with nano-particle including nano-potassium, nano-silicon and control treatment chosen as sub plot. The results indicated the most panicle length and plant height had obtained for Tarom Hashemi cultivar. Third and fourth internode bending moment in Tarom Hashemi was more than Tarom Mahalli. Fourth internode breaking resistance for Tarom Hashemi equal to 6.55% was more than Tarom Mahalli. But third internode bending moment was less. The highest fourth internode bending moment in both years was obtained with nanosilicon application. In both years third and fourth internode lodging index in Tarom Hashemi was more than Tarom Mahalli. With nano potassium using in first year the highest internodes lodging index was observed with nano potassium consumption. For Tarom Hashemi the highest third internode breaking resistance was obtained with nitroxin application.

INTRODUCTION

Rice is one the most important crops in developing countries and a main food stuff for about 35% of the whole world population[1]. Rice plants require large amounts of mineral nutrients including N for their growth, development and grain production[2]. Rice continuous cultivation in the North of Iran has recently decreased rice production and farmers for increasing yield used nitrogen application resulting in coast increasing and production decreasing duo to highland sensitive to disease, especially blast and lodging where disease and lodging have caused major yield losses. Rice production in much of the world increasingly focuses on optimizing grain yield, reducing production costs and minimizing pollution risks to the environment[3]. Nitrogen nutrition is critical in yield realization of irrigated rice ecosystems. Nitrogen is clearly the most limiting element, we proposed a set of basic guidelines for improved nutrient management which after further efforts of all stakeholders involved, could contribute to increased system productivity[4]. Nitrogen fertilization increased the number of stems and panicles per square meter and the total number of spikelet's, reflecting on grain productivity. Excessive tailoring caused by inadequate nitrogen fertilization reduced the percentage of fertile tiller; filled spikelet percentage and grain mass[5]. N application significantly increased grain yield largely through an increased biomass and grain number[6]. Nitrogen rates of 138 and 0 kg ha^{-1} produced maximum and minimum grain yield, biological yield and straw yield, respectively. Si at 500 and 0 kg ha^{-1} produced maximum and minimum biological yield with 11874 and 10538 kg ha^{-1} and straw yield, respectively. It is necessary element for rice because of positive effaces on rice planting[7]. Silicon uptake is activated in rice and wheat, so, it's not be affected by the rate of transpiration and this element is located in leaf, sclerenchyma, vascular tissues and vascular sheaths, old leaves have more silicon than the young leaves[8]. Silicon caused to be vertical in leaves, increase to resistance in fungal diseases[9] and caused to increase filled spikelet's percentage and grain yield[10]. Silicon caused to increase total number of spikelets per panicle, filled spikelet's percentage, 1000-grain weight and grain yield and to decrease lodging[11]. Silicon increase vegetative growth, dry matter and decrease transpiration and affects on qualitative and grain yield[12]. Silicon is necessary for grain yield stability in rice[5]. Silicon application showed direct growth in leaves stems and plants sheaths especially in rice consequently silicon application improved light contributing inside of canopy[13]. Silicon uptake is different in varieties and parts of plants[14]. Optimal silicon application increase tolerance of plants to salinity and drought. Silicon improved plant height, inter-node length, fresh weight, bending moment, breaking resistance, lodging index and increase tolerance of lodging in rice. Maschmann *et al*.[15] indicated that potassium deficient rice is susceptible to diseases including stem rot (Sclerotium oryzae Catt). Maschmann *et al*.[14] showed that potassium fertilization increased grain yield by 8-11% above rice receiving no Slaton, etc., founded that rice having whole-plant K concentrations of 23.1 g kg^{-1} at panicle differentiation and 13.0 g kg^{-1} at early heading were predicted to produce 95% relative yield. The predicted K-fertilizer rates required to optimize rice grain yield depended on the model and ranged from 51-90, 41-70, 30-55 and 20-35 kg K ha^{-1} for soil having Mehlich-3 soil K concentrations of 60, 70, 80 and 90 mg K kg^{-1}, respectively. K uptake by plants is similar to that of N, however and is usually an order of magnitude greater than that for P. Potassium and stover management are critical to the uplands of Sitiung, Indonesia where the predominant cropping system is upland rice followed by soybean or peanuts. Maschmann *et al*.[14] founded that potassium fertilizer applied between panicle differentiation and late boot can reduce yield losses from K deficiency. Although, soil acidity and low soil P are the major fertility constraints in soils Ultisols and Oxisols, K usually becomes limiting to crop growth under continuous cultivation. Thomas and Yost[16] showed that soil and crop management factors also contribute to the occurrence of K deficiency. Additionally, removing crop stover from the field hastens the depletion of soil K. Although, K can be replenished through fertilization, excessive fertilization can result in leaching losses[17] and in losses from the luxury consumption of K when stover is not returned[16]. Also, Thomas and Yost[16] showed that rice straw in upland rice system is usually burned in piles after threshing. Even if farmers rotate the location of the rice burn piles each season, incorporation of burnt stover generally results in an uneven distribution of nutrients, which can hasten nutrient depletion[16]. So, according to nitrogen, silicon and potassium importance on growth and yield an experiment was carried out entitled: nano particles and nitrogen amount on growth parameters of two Iranian rice cultivars.

MATERIALS AND METHODS

The field experiment was conducted at Sari region in the North of Iran (Latitude 36°38 N, Longitude 53°12 E and altitude 13.5 m above sea level) in 2013e2014. The soil chemical analysis indicates (Table 1). The minimum and maximum daily temperatures were obtained from Mazandaran airport at Sari near to farm (Table 2).

Rice cultivars were chosen as main plots including Tarom Mahalli and Tarom Hashemi. Nitrogen rates 34 and 69 kg N ha^{-1} and nitroxin with nano-particle including nano potassium, nano silicon and control treatment chosen as sub plot.

Clean seeds with a minimum of 95% germination rate were soaked in water for 24 h and incubated for another 24 h. Then, the pre-germinated seeds were sown in seedling trays filled with soil to produce uniform seedlings. Total number of unit was 48 plots, the size of each plot being 2×5 m^2. After transplanting, five cm water depth was maintained in the experimental plots. Ten days before harvest, the plots were drained to facilitate harvesting. Insects, diseases and weeds were intensively controlled to avoid any yield loss. Phosphorous fertilizers were used at the rates of 100 kg P_2O_5 ha^{-1} as urea and triple superphosphate as basal fertilizers were applied, respectively. Basal fertilizers were applied and incorporated in all plots 1 day before transplanting. Nitrogen was split-applied: 50 kg N ha^{-1} at basal, 50 kg N ha^{-1} at panicle initiation, 50 kg N ha^{-1} at full heading by hand broadcast method.

Table 1: Selected soil properties for composite samples at experimental site

Soil character	Units	2013	2014
Soil depth	cm	0-30	0-30
EC	dSm^{-1}	0.68	0.62
pH	-	7.8	7.6
Organic matter	%	1.5	1.4
N	%	0.12	0.10
P	ppm	8	9
K	ppm	140	165
Mg	mg kg^{-1}	704	680
Fe	mg kg^{-1}	33.7	29
Mn	mg kg^{-1}	8.3	7.6
Zn	mg kg^{-1}	1.2	1.4
Cu	mg kg^{-1}	3.9	3.5
Soil texture	-	Clay	Loam clay

Table 2: Weather condition in experiment site in rice growth stages

Months	Amount of rainfall (Mm)	Minimum temperature (°C)	Maximum temperature (°C)	Monthly evaporation (Mm)
20 Mar.	12.4	110.3	20.5	9.2
20 Apr.	12.0	91.5	19.3	9.8
20 Apr	10.6	187.5	27.0	15.8
20 May	42.6	134.9	24.6	13.2
20 May	41.4	222.5	20.6	19.8
20 June	9.3	166.4	29.1	18.7
20 June	16.8	144.1	30.0	22.2
20 July	00.0	217.3	31.7	21.2
20 July	2.6	204.6	34.1	23.1
20 Aug.	29.5	133.4	30.3	21.4
20 Aug.	100.3	135.7	29.9	21.1
20 Sep.	10.8	122.2	31.1	21.4

Twelve hills (0.48 m^2) were sampled diagonally from harvest area each plot at maturity to determine plant height, number of tiller per hill, number of effective tiller per hill. Plant height was measured from the plant base to the tip of the highest leaf (or panicle whichever was longer) for all 12 hills in each plot. Prior to harvest, the plants from 10 hills were obtained from each replication to measure yield components. Grain and biological yields and harvest index were determined from the 5 m^2 area in each plot and adjusted to the standard moisture content of 140 g H_2O kg^{-1}. Plants were separated into straw and panicles. Straw yield was determined after oven drying at 70°C to constant weight. Harvest index was calculated as the ratio of filled spikelets weight to aboveground biomass.

Lodging characteristic was observed when the flowering of the plant just started. Culm characters related to lodging were determined at 30 days after flowering. Three representative hills were sampled from each plot and the 12 largest tillers, 4 from each hill were used to measure characters related to lodging. Culm height (length between plant base and panicle neck node) and the lengths of the third (N_3) and fourth (N_4) internodes from the top were measured. Fresh weight of the upper portion of the plant, including panicle and N_1 and N_2 with leaf and leaf sheath (W_1), was measured. The fresh weights of the third (W_2) and fourth (W_3) internodes with leaf sheath were also measured. Bending Moment (BM) at N_3 or N_4 internode was calculated using the following formula[18]:

$$BMN_3 = \text{Length from the lowest node of } N_3 \text{ to the top of panicle} \times (W_1+W_2)$$

$$BMN_4 = \text{Length from the lower node of } N_4 \text{ to the top of panicle} \times (W_1+W_2+W_3)$$

Then, bending moment was measured as culm length×plant fresh weight. Since, stem lodging usually occurs at the lowest internodes, only the diameter of N_4 was measured near the lowest node of N_4 after removing the leaf sheath. Length was calculated for both N_3 and N_4. Plant stems diameter was measured with a slide caliper according to the method described previously[19]. Statistical analysis data of morphological traits were analyzed following analysis of variance (SAS) and means were compared based on LSD multiple range test at the 0.05 probability level.

RESULTS AND DISCUSSION

Third and fourth inter node length: Third inter-node length had significant effect under cultivar in both years in 1% probability level. At first year this trait was significant on nano particle affect and interaction of cultivar and nano particle. At second year this character was significant at triple interaction in 5% probability level (Table 3). Fourth inter-node length only at first year in significant effect on cultivar and nitrogen in 1% (Table 4). In first year, the most 3rd inter node length had obtained for Tarom Hashemi cultivars with nano potassium and nano silicon consumption (27.39 and 27.81 cm) and the least 3rd inter node length equal to 23.87 cm was observed for Tarom Mahalli cultivar with nano silicon using. At triple interaction maximum 3rd inter node length for Tarom Hashemi was observed with 69 kg N ha^{-1} and nano potassium application and nitroxin using and control treatment equal to 31.18 and 31.7 cm, respectively. At first year, 4th inter node length for Tarom Mahalli (17.41 cm) was more than Tarom Hashemi (15.29 cm). The most 4th inter node length 17.66 cm was observed with 69 kg N ha^{-1} (Table 5 and 6).

Third and fourth inter node diameter: Third inter node diameter at first year had significant effect under nano particle effect and double interaction of cultivar and nano particle in 1% probability level. In second year, this parameter was significant and simple treatment effect as this character significant in 5% probability level on double interaction of cultivar and nano particle. Fourth inter node diameter had significant under nano particle simple effect and double interaction of cultivar and nano particle. At second year this character had significant in all of simple

Table 3: Mean square of nitrogen and silicon rates on lodging related characteristics in rice

		3rd inter-node length		4th inter-node length		3rd inter-node diameter		4th inter-node diameter		Panicle length		Plant height	
S.O.V	df	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Rep	2	2.7	0.50	7.5	8.7*	0.10	0.12	0.31	0.29	4.47*	2.5	72.6*	34.9**
Cultivar (C)	1	61.1**	3.64**	61.2**	0.65	0.13	6.4**	0.05	9.9**	2.07**	3.77**	10.48**	230.2**
RC	2	7.2	0.02	15.4	1.2	0.02	0.21	0.23	0.51	0.26	3.1	45.9	38.2
Nitrogen (N)	2	8.3	0.97	23.4**	1.4	0.05	0.64*	0.02	0.67*	0.92	0.84	82.1*	98.3
C×N	2	2.2	0.13	3.2	2.1	0.12	0.12	0.45	0.22	1.1	0.90	3.7	17.2
Nano (P)	2	16.6*	0.08	2.7	0.91	1.6**	0.52*	1.8**	0.51*	1.5	4.2*	13.01	15.8
C×P	2	12.2*	3.73	6.4	2.6	1.4**	0.60*	1.6**	0.23	1.4	1.9	35.6	12.3
N×P	4	5.9	0.98	6.1	2.2	0.34	0.23	0.29	0.22	3.2	3.7*	46.3	44.5
C×N×P	4	3.2	5.02*	3.6	3.2	0.19	0.21	0.33	0.23	1.2	0.92	23.7	19.7
Error	32	4.4	1.51	3.2	3.5	0.19	0.16	0.29	0.20	1.6	1.6	22.5	43.2
C.V. (%)	-	8.14	4.42	10.89	10.81	8.97	8.98	9.63	8.49	4.78	4.84	3.60	4.81

**and*, respectively significant in 1 and 5% level

treatment (Table 3). The most 3rd inter node diameter at first year 5.45 mm was observed for Tarom Hashemi cultivar with nano silicon applied. The least of that 4.29 mm was achieved for Tarom Hashemi in control treatment. At second year the highest 3rd inter node diameter 4.91 and 4.83 mm was observed for Tarom Hashemi cultivar with control treatment and nano silicon consumption. The most 4th inter node diameter 6.07 mm was observed for Tarom Hashemi with nano silicon application. The least of that 4.88 mm was observed for Tarom Hashemi in control treatment (Table 5 and 6).

Fourth inter node diameter at second year for Tarom Hashemi (5.68 mm) was more than Tarom Mahalli (4.82 mm). The maximum 4th inter node diameter 5.46 mm was obtained with nitroxin application. The most 4th inter node diameter (5.44 mm) was achieved with nano silicon applied. The least of that 5.13 mm was observed with nano potassium consumption (Table 5 and 6).

Panicle length and plant height: Plant height and panicle length had significant effect under cultivar treatment in 1% probability level in both years. At second year panicle length was significant on nano particle effect and double interaction of nitrogen and nano particle. Plant height at first year as significant on nitrogen simple effect in 5% probability level (Table 3). In both year panicle length for Tarom Hashemi (27.72 and 28.97 cm) was more than Tarom Mahalli cultivar (24.81 and 23.68 cm) as plant height for Tarom Hashemi in both year (136.26 and 143.14 cm) was more than Tarom Mahalli cultivar (127.45 and 130.08 cm). For nitrogen effect the most plant height 133.87 cm was observed with 34 kg N ha^{-1} and the keast plant height 129.62 cm was achieved with nitroxin using table. At double interaction of nitrogen and nano particle maximum panicle length was observed with 34 and 69 kg N ha^{-1} with nano silicon consumption (equal to 27.02 and 27.15 cm) and nitroxin using with control treatment 27.13 cm. the lowest panicle length was observed in other effect (Fig. 1).

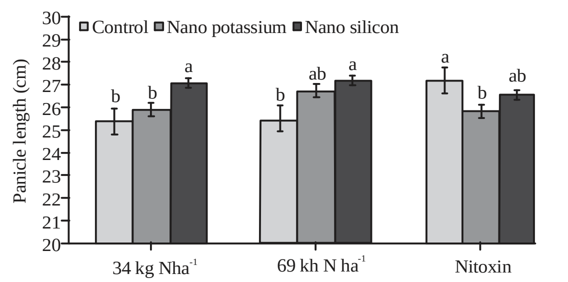

Fig. 1: Interaction of nitrogen and nano particle on panicle length

Third and fourth inter node bending moment: Third inter node bending moment in both year at simple affect of cultivar and nano particle and double interaction effect of them. As, Fourth inter node bending moment was significant effect under nano particle simple effect and double interaction of cultivar with nano particle. At second year this parameter had significant effect in 1% probability level on cultivar treatment (Table 4). At double interaction of cultivar and nano particle showing that at first year the most 3rd and 4th inter node bending moment equal to 1038.75 and 1369.8 g cm^{-1} was achieved for Tarom Hashemi cultivar with nano silicon application. The least 3rd and 4th internode bending moment in both at first year was obtained for Tarom Hashemi cultivar in control treatment equal to 702.75 and 972.31 cm at second year the highest 3rd and 4th inter node bending moment equal to 653.03 and 1079.44 cm was obtained for Tarom Hashemi in control treatment and the lowest of that had obtained for Tarom Mahalli with nano potassium consumption (Table 5 and 6).

Third and fourth inter node breaking resistance: Third inter node breaking resistance in both years had significant on cultivars treatment in 1 percent probability level. At first year this character had significant on nitrogen and nano particle simple effect as double interaction of C×N and C×P and triple interaction of

Table 4: Mean square of nitrogen and silicon rates on lodging related characteristics in rice

		3rd inter-node bending moment		4th inter-node bending moment		3rd inter-node breaking resistance		4th inter-node breaking resistance		3rd inter-node lodging index		4th inter-node lodging index		Panicle yield	
S.O.V	df	2013	2014	2013	2014	2013	2014	2013	2014	2013	2013	2014	2013	2014	2013
Rep	2	57527*	18453	74128	46328	10.1*	20.4*	9.3	8.8	53.3	182*	46.6	276	683252*	126706
Cultivar (C)	1	99798*	178266**	74170	804933**	48.9**	73.5**	25.4*	6.2	1879**	1247**	1.3	2016**	1622400**	1284980**
RC	2	24799	10977	35618	19366	4.5	16.6	5.5	0.70	33.4	17.4	34	84.9	334822	147424
Nitrogen (N)	2	22091	4159	33061	3819	9.9	4.2	38**	26*	309*	54.1	113	82.6	4924	42017
C×N	2	6357	5343	21171	14099	15.1*	9	1.7	13.1	26.3	1.8	59.3	55.2	115772	110813
Nano (P)	2	110685*	49708*	163903*	67892*	13.1*	3.8	4.9	8.9	440.9	217*	181	241	382813	254772
C×P	2	153978**	37105	198301**	79219*	28.1**	5.7	2.9	3.1	1585**	77.9	498*	146	106672	10279
N×P	4	30790	20993	46848	27732	7.8	1.5	13.2*	5.4	42.2	83.9	183	82.9	343777	181497
C×N×P	4	29520	1374	54544	9192	11.5*	3.9	16.7*	7.7	274.6	7.8	219	12.2	334403	476671*
Error	32	22644	12613	30956	21009	3.96	3.9	3.9	8.8	127	62.6	95.3	113.8	180404	159806
C.V. (%)	-	18.06	19.95	15.53	16.39	12.26	10.70	9.19	12.75	21.29	25.03	18.40	27.35	9.37	9.32

**and*, respectively significant in 1 and 5% level

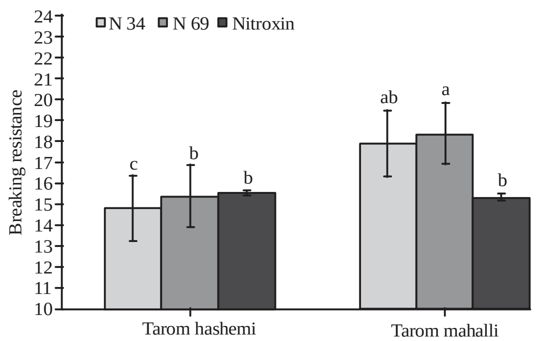

Fig. 2: Interaction of cultivar and nitrogen on third inter node breaking resistance

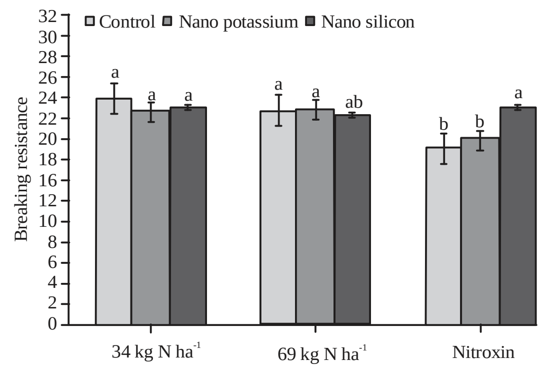

Fig. 3: Interaction of nitrogen and nano particle on fourth inter node breaking resistance

C×N×P (Table 4). Fourth inter node breaking resistance at first year has significant on simple effect of cultivar and nitrogen and interaction of N×P and C×N×P. At second year this parameter was significant in 5% on nitrogen simple effect (Table 5 and 6). At first year 3rd inter node breaking resistance for Tarom Hashemi with nitroxin application and control treatment was highest (31.7 g/stem) the least of that 12.59 g/stem was observed for Tarom Hashemi with nano potassium using. For Tarom Mahalli the highest amount of this parameter 19.78 g/stem was achieved with 34 kg N ha^{-1} and nano potassium application. 4th inter node breaking resistance at first year for Tarom Hashemi was highest in N1P1 (25.81 g/stem) and this parameter for Tarom Mahalli was the most amount 23.69 g/stem with N1P2 treatment (Fig. 3 and 4).

Third and fourth inter node lodging index: Third inter node lodging index in both year had significant on cultivar and nano particle effect. At first year this parameter was significant on nitrogen simple effect and double interaction of C×I. The 4th inter node lodging index at first year had significant only in double interaction of C×I. At second year this character only significant on cultivar treatment in 1% probability level (Table 4). At first year 3rd inter node lodging index was highest 68.12% for Tarom Hashemi with nano silicon applied and the lowest 40.35% was achieved for Tarom Mahalli with nano silicon consumption. The highest 4th inter node lodging index 60.19% had observed for Tarom Hashemi with nano silicon application and the least of that 43.88% was obtained for Tarom Hashemi in control treatment (Table 5 and 6). At second year 3rd and 4th inter node lodging index for Tarom Hashemi was more than Tarom Mahalli. At second year the most 3rd inter node lodging index 35.48% was achieved with nano silicon applied (Table 5 and 6).

Paddy yield: This parameter had significant effect under simple cultivar treatment in 1% probability level in both years. At second year paddy yield was significant in 5% on triple interaction of C×N×P (Table 4). Paddy yield for Tarom Hashemi in both years was more than Tarom Mahalli. At triple interaction shown that the highest paddy yield for Tarom Hashemi was produced 5000 kg ha^{-1} with 69 kg N ha^{-1} and nano potassium application. The least paddy yield for this cultivar 4133 kg ha^{-1} was observed with nitroxin applied and control treatment. For Tarom Mahalli the most paddy yield 4657 kg ha^{-1} had obtained with 34 kg N ha^{-1} and nano potassium consumtion. The least of that 3667 kg N ha^{-1} was observed in 34 kg N ha and control treatment (Table 6).

Saadati and Fallah stated stem length had significant effect in tillering time by nitrogen contributing treatments in 1% probability level. Panicle length affects in grain yield by more transport of photosynthesis material[20].

Table 5: Interaction of cultivar and nano particle on lodging parameter

LI4 (%)	LI3 (%)	BR3 (g/stem)	4th inter-node bending moment		3rd inter-node bending moment		4th inter-node diameter (mm)		3rd inter-node diameter(mm)		3rd inter-node Length (cm)		
2013	2013	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	Interaction
43.9b	43bc	16.6b	1079.4a	972.3d	65.3a	702.7c	ns	4.88b	4.91a	4.29c	ns	24.9b	C_1P_1
54.7ab	65.3a	13.9d	916.3b	1168.3b	571.2bc	886.9b	ns	5.72ab	4.71ab	4.91b	ns	27.3a	C_1P_2
60.2a	68.1a	15.3c	1023.1a	1369.8a	636.7ab	1038.7a	ns	6.07a	4.83a	5.45a	ns	27.8a	C_1P_3
55ab	51.9b	15.7c	683.2e	1090.7c	441.9c	789.4bc	ns	5.59ab	3.85c	4.77bc	ns	24.2bc	C_2P_1
54.4ab	48.8b	16.9b	732.2d	1125.6b	468.1c	823.6b	ns	5.65ab	4.03bc	4.077bc	ns	25.6ab	C_2P_2
50.3ab	40.4c	18.9a	870.9c	1071.9c	606.1b	757.5bc	ns	5.61ab	4.5bc	4.82b	ns	23.7bc	C_2P_3

Values within each column followed by same letter are not significantly different at LSD (p = 0.05)

Table 6: Triple mean comparison of C×N×P on some of rice growth traits with slice interaction

Paddy yield (kg ha^{-1})		BR4 (g/stem)		BR3 (g/stem)		Third inter node length (cm)		
2014	2013	2014	2013	2014	2013	2014	2013	Interaction
4533bc	ns	ns	25.81a	ns	16.03b	29.61b	ns	$C_1 N_1 P_1$
4200cd	ns	ns	20.43bc	ns	12.59d	30.85ab	ns	$C_1 N_1 P_2$
4400bcd	ns	ns	24.21ab	ns	15.88b	30.28ab	ns	$C_1 N_1 P_3$
4267cd	ns	ns	22.55b	ns	15.73b	30.43ab	ns	$C_1 N_2 P_1$
5000a	ns	ns	24.45ab	ns	16.14b	31.18a	ns	$C_1 N_2 P_2$
4500bc	ns	ns	21.96b	ns	14.59c	30.35ab	ns	$C_1 N_2 P_3$
4133d	ns	ns	18.93d	ns	18.21a	31.70a	ns	$C_1 N_3 P_1$
4337cd	ns	ns	20.09c	ns	12.99cd	29.67b	ns	$C_1 N_3 P_2$
4633b	ns	ns	22.08b	ns	15.43bc	29.06c	ns	$C_1 N_3 P_3$
3667c	ns	ns	21.03bc	ns	15.25c	24.88b	ns	$C_2 N_1 P_1$
4657a	ns	ns	23.69a	ns	19.78a	23.81c	ns	$C_2 N_1 P_2$
4200ab	ns	ns	20.65c	ns	18.67ab	26.12a	ns	$C_2 N_1 P_3$
4033b	ns	ns	21.83c	ns	18.00b	25.89ab	ns	$C_2 N_2 P_1$
4200ab	ns	ns	20.35c	ns	17.63b	24.96b	ns	$C_2 N_2 P_2$
4067b	ns	ns	21.50b	ns	19.38a	25.29ab	ns	$C_2 N_2 P_3$
4303ab	ns	ns	17.61d	ns	13.83d	23.88c	ns	$C_2 N_3 P_1$
3900bc	ns	ns	18.75cd	ns	13.40d	25.70ab	ns	$C_2 N_3 P_2$
4200ab	ns	ns	22.75ab	ns	18.78ab	25.85ab	ns	$C_2 N_3 P_3$

Values within each column followed by same letter are not significantly different at LSD (p = 0.05)

Saadati and Fallah stated panicle length had significant effect in tillering time by nitrogen contributing treatments in 1% probability level. Mobasser *et al*.[21] found that panicle length had significant effect by interaction year×nitrogen amounts×nitrogen contributing in 5% probability level. Absorbed silicon is located on leaf area in rice and by this, decreased cuticle transpiration and it decreases plant elongation[10]. Silicon improved plant height, inter-node length and fresh weight in rice. Yoshida[22] stated that plant height increased by increase of sodium silicate levels because of silicon effect on straight stature of leaves. Agarie[12] showed silicate fertilizers increased vegetative growth, dry matter and grain yield. Saadati and Fallah stated plant height had significant effect in tillering time by nitrogen contributing treatments in 1% probability level. Sedghi[23] reported that silicon had no significant effect on flag leaf length and this result supported our experiment. Pantuwan *et al*.[24] stated that grain yield had a positive correlation and significant with flag leaf length. Yoshida[22] stated that inter-node length decreased by <40 kg h^{-1} nitrogen application. 3rd and 4th inter-nodes length are important for morphological characteristics related to lodging, because the most lodging were happened in this two areas, on the other hand 3rd and 4th inter-nodes length have positive correlation with lodging index[17]. Silicon contents in rice stem had a direct relation with lodging resistance[25]. Mobasser *et al*.[20] found that bending moment of 4th inter-node decreased by 500 kg h^{-1} silicon but it didn't support our results. Pantuwan *et al*.[23] reported that grain yield had positive correlation with flag leaf length. Chaoming *et al*.[10] stated that silicon application increased grain yield by increase of spikelet number, filled spikelet percentage and 1000-seed weight. Mauod *et al*.[5]; Mobasser *et al*.[20] reported that grain yield increased by silicon application. Maximum grain yield was obtained by 69 kg h^{-1} nitrogen and nitrogen contributing in three times (transplanting time, panicle initiation and heading time)[20]. Grain yield increased by 120 kg h^{-1} nitrogen contributing in three times (transplanting time, tillering time and panicle initiation)[26]. Agarie[11] showed that silicate fertilizers increased dry matters by effect on vegetation growth consequently increase grain yield. Matsuo and Hoshikawa[27] stated that silicon increased vegetation growth and dry matter. Sedghi[22] reported that grain yield increased by silicon application. Morphologic traits related to lodging measured only for third and fourth internodes because the stem lodging usually happens in lower internodes[18]. Islam *et al*.[17] reported that the length of stem has the positive correlation coefficient with the diameter of fourth internode, the length of first, second third and fourth internodes and also with the breaking resistance of third and fourth internodes but doesn’t have the significant correlation with the dry weight, bending moment and lodging index of 3 and 4 nodes. Maoud *et al*.[5] reported that silicon with guttering in lemma ad plea because to increase 1000-grain weight but Mobasser *et al*.[20] stating that application of calcium silicate with increase number of filled spikelet per panicle due reduce 1000-grain weight. Nolla, etc., expressed that silicon has effect on 1000-grain weight. Silicon foliar application has increase phosphorus rate of grain and 1000-grain weight. Ahmad, etc., found that silicon cause to increase number of total spikelet per panicle. As, Nolla, etc., was stating these results. Nolla, etc., found that silicon use with reduce lodging and increase number of filled spikelet per panicle and 1000-grain weight due increase grain yield. Application of magnesium silicate cause to increase grain yield equal to 21-32% in rice. Silicic acid foliar application with 10 days distance in rice plant was cause to increase number of panicle per plant due increased grain yield. Potassium silicate application cause to increase grain yield equal to 34.2% compare to control treatment. Application of 2 ton per hectare calcium silicate cause to increase number of tiller per hill and panicle length as due increase 25-30% in grain yield compare to control treatment. The highest grain yield was arrived with use of 100 kg N ha^{-1}. Silicon use with increase tolerance to drought and number of tiller per plant had due to increase grain yield and dry matter in plant.

CONCLUSION

The most fourth internode bending moment for Tarom Hashemi was obtained with 34 kg N ha^{-1} and control treatment. Paddy yield in both year for Taom Hashemi equal to 9.6 and 7.46% was more than Tarom Hashemi. Main reason of that is increasing panicle length, fertile tiller number and filled spikelet number for this cultivar. For Tarom Hashemi the most paddy yield (5000 kg ha^{-1}) was produced with 69 kg N ha^{-1}. For Tarom Mahalli cultivars the most paddy yield (4657 kg ha^{-1}) was obtained with 34 kg N ha^{-1} and nano potassium application. Therefore, nano particle consumption in both cultivars had cause to decrease lodging index that is cause to increasing paddy yield.

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