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ARTICLE

Influence of Briquette Fertilizer of Levels of Nitrogen and Silica on Paddy

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ABSTRACT

Nitrogen is the major nutrient plays a key role in the production of rice crop and the lateritic soils are low in available nitrogen content. Accordingly, the field study was carried out in lateritic soils of Konkan (*Coastal*) region during year (2017 - 2018) to find out the effect of different levels of nitrogen along with silica levels on growth and yield of rice. The major aspect behind taking this kind of research was to see the interaction between the applications of varying levels of nitrogen with the different levels of silica. An experiment was carried out with FRBD design. The nitrogen was given by the Konkan Annapurna Briquettes (KAB) which is the compressed tablet type mixture of the fertilizer which is having major nutrients N, P and K. Silica was applied solely through potassium silicate with the paper packets. There might have been positive response with growth and silica levels also with the rate of application of nitrogen with the increased levels of silica. It was observed that the application of 80 per cent RDN through Konkan Annapurna Briquettes (KAB) with Silica @ 100 kg ha-1 which was applied between four hills was found promising in enhancing the growth and yield of Ratnagiri-24 Cv. in lateritic during *Kharif* season. It could be concluded that, the application of nutrients in the form of Konkan Annapurna Briquettes along with the application of silica can reduce the recommended dose of fertilizer to the extent of 20 per cent during *Kharif* season in Konkan region.

1. Introduction

Rice (*Oryza sativa* L.) belonging to family *Poaceceae,* one of the most important staple food grain crop of the world. Rice is also an important cereal food crop of Maharashtra state, which contributes 3.6 per cent of area and 2.8 per cent of production of rice at national level. In Konkan region, rice occupies an area of 3.79 lakh hectares with production 9.94 lakh tonnes and productivity of 2.61 tonnes ha^{-1} [2]. Nitrogen fertilization plays a great role in increasing rice production. Nitrogen is one of the most mobile plant nutrients in the soil as well as in plant also. Nitrogen impact green colour to plant encourages vegetative growth. Nitrogen is essential constituent of protein. It is also constituent of protoplasm of chlorophyll and co-enzyme. It plays important role in synthesis of Auxin. The total nitrogen uptake and the nitrogen use efficiency by hybrid rice is also higher [11,34].

In high rainfall regions like Konkan, there are heavy

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losses of fertilizer N applied by broadcast method through various mechanisms *i.e.* runoff, volatilization, leaching and denitrification resulting into poor nutrient recovery [33].

Earlier studies carried out in this university indicated that the placement of N and N+P through paper packets were used [3], urea placement behind plough was modified after the application through packets [30,32] and deep placement of urea super granules (USG) and UB-DAP [25] seemed very promising in order to improve the NUE and nutrient recovery in transplanted rice. Therefore, it would be better if all the three major plant nutrients are used in the briquette form. Presently there is the myth that the farmers are applying high dose of Nitrogen, beyond recommended doses ranging from 160 to 220 kg ha^{-1} but in fact the farmers are using less fertilizers than the recommendations even. Yes obviously it is true in the coastal region of konkan farmers are using the nitrogenous fertilizers mostly at high doses, hence the N use efficiency may be low besides leading to other ill effects of lodging and susceptibility to pests and disease. These effects could be minimised by use of silicon, so application of silicon is found to be improved N use efficiency besides reporting resistance to pest and diseases (Rajamani, 2012).

Silicon is added to plants as a fertilizer, which can be in liquid or solid state usually applied at the time of planting, but it can be applied at any time during the growing season. Here in this university one ongoing experiment is being taken by the scientist where it was noticed that the foliar application of silica increases the yield of rice with higher concentration in single spray at tillering stage. Silicon fertilizers in agriculture are still not widespread and they are considered as a modern farm technology, side by side with microbiological fertilizers. Since it's a natural element, silicon based fertilizers can use all farmers, whether they practice integration, conventional or organic farming. Information on the importance of Si in Indian rice farming system is limited [21]. There is need to identify silicon deficient soils, for determining desired rates of silicon fertilization and for assessing various silicon fertilizer sources. Rice and sugarcane are Silicon (Si) accumulator plants. No other crop requires as high Si as required by rice and sugarcane.

Si plays a noteworthy role in conveying both biotic and abiotic stress resistance and boosts productivity. Si is also an element which is worked as potassium that does not damage plants upon its excessive accumulation. High accumulation of Si in rice has been established to be necessary for healthy development and great steady production. For this reason, Si has been recognized as an "agronomically essential element" in Japan and silicate fertilizers have been applied to paddy soils [12]. Rice is a known silicon accumulator [29] and the plant is benefited from Si nutrition [27]. Consequently there is a definite need to think through it for considering as an essential minor element to increase sustained rice productivity [28].

Several studies suggest that Si enhances disease resistance in plants, imparts turgidity to the cell walls and has a putative role in mitigating the metal toxicities [4,5]. It is also advised that Si plays a vital role in checking the lodging in the cereal crops, a matter of great importance in terms of agricultural productivity.

Seven international conferences on SILICON IN AGRICULTURE were organised at many parts of the world since 1999. As such, many of the plant scientists from India are aware of the importance of silicon in agriculture especially as it relates to plant health and soil productivity. In India, though research on silicon has been initiated earlier, the necessity for silicon fertilization to the rice crop has not been widely evaluated as in other countries.

2. Material and Methods

A field experiment was conducted during *kharif* season 2017 at Experimental Farm, Department of Soil Science and Agril. Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri which is situated in subtropical region at $17^0 19$' North and $73^0 1$' East longitude having altitude of 250 meters above mean sea level. The climate is subtropical, warm and humid which is favourable for rice crop during *kharif* season. The average annual precipitation of Dapoli is nearly 3150 mm distributed from the beginning of June to October in about 95 to 110 days. The soil of experimental site was Sandy clay loam in texture with pH 5.21, EC 0.17 dS m^{-1}, Organic Carbon 16.1 g kg^{-1}, available nitrogen 406.98 kg ha^{-1}, phosphorus 20.18 kg ha^{-1}, potassium 381.02 kg ha^{-1} and Silica (acetic acid extractable) 310.12 kg ha^{-1}.

The experiment was laid out in factorial randomized block design comprising of sixteen treatment combinations with three replications. The four levels of Nitrogen through KAB and four levels of Silica through potassium silicate were used for this experiment. Rice (*Oryza sativa* L.) var. Ratnagiri-24 was taken as a test crop during *kharif* season 2017 with a spacing 15 x 20 cm^2. In order to study the effect of various treatments on the growth parameters, yield contributing characters and yield were recorded at 30 DAT, 60 DAT and at harvest. The details of the treatments are given in the table 1.

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Table 1. The details of the treatments

Sr. No.	Treatment Combination	Description of treatment Combination
1	N0Si0	Absolute control
2	N0Si1	Silica 50 kg ha-1 through potassium silicate
3	N0Si2	Silica 75 kg ha-1 through potassium silicate
4	N0Si3	Silica 100 kg ha-1 through potassium silicate
5	N1Si0	40% RDN through KAB
6	N1Si1	40% RDN through KAB + Silica 50 kg ha-1 through potassium silicate
7	N1Si2	40% RDN through KAB + Silica 75 kg ha-1 through potassium silicate
8	N1Si3	40% RDN through KAB + Silica 100 kg ha-1 through potassium silicate
9	N2Si0	60% RDN through KAB
10	N2Si1	60% RDN through KAB + Silica 50 kg ha-1 through potassium silicate
11	N2Si2	60% RDN through KAB + Silica 75 kg ha-1 through potassium silicate
12	N2Si3	60% RDN through KAB + Silica 100 kg ha-1 through potassium silicate
13	N3Si0	80% RDN through KAB
14	N3Si1	80% RDN through KAB + Silica 50 kg ha-1 through potassium silicate
15	N3Si2	80% RDN through KAB + Silica 75 kg ha-1 through potassium silicate
16	N3Si3	80% RDN through KAB + Silica 100 kg ha-1 through potassium silicate

Note:
(RDN- Recommended dose of Nitrogen; KAB- Konkan Annapurna Briquette)

The Konkan Annapurna briquettes were prepared as per the ratio of fertilizers combination used with the help of "Kranti Briquetter". The 1:1.5 (Godavari to Urea) ratios was used for preparation of briquettes. The details like average length, breadth, shape and Ratio of fertilizers used for briquette preparation are given in table 2.

Table 2. Compositon and shape of briquette

Sr. No	Briquette (Proportion)	Ratio	Avg. Length (cm)	Avg. Breadth (cm)	Avg. Weight (g)	Shape
1	Godavari (14:35:14) : Urea	1:1.5	3.10	2.13	2.71	Oval Flat

2.1 Briquettes and Silica Application

Treatment wise Konkan Annapurna Briquettes (KAB) and potassium silicate was placed manually at about 7 to 10 cm @ one briquette for KAB and one paper packet of potassium silicate for every four hills of rice at the spacing of 15 x 20 cm^2.

2.2 Statistical Analysis

The data have been analyzed with appropriate method of statistical analysis [18]. Interpretation of result was based on 'F' test. The comparison among means was made by calculating critical difference (CD) at 5 per cent level of significance.

Table 3. Nutrient content in various fertilizers and briquettes

Sr. No	Fertilizer/Briquette	Nutrient content (%)			
		N	P_2O_5	K_2O	Si
1	Konkan Annapurna briquette	34	14	6	-
2	Potassium silicate	-	-	32	52

Table 4. Total nutrient added in each treatment

Sr. No	Treatment Combination	N (g Plot-1)	P2O5 (g Plot-1)	K2O (g Plot-1)	Si (g Plot-1)
1	N0Si0	-	-	-	-
2	N0Si1	-	-	187.5	115.38
3	N0Si2	-	-	281.25	173.08
4	N0Si3	-	-	375.00	230.76
5	N1Si0	141.17	19.75	8.47	-
6	N1Si1	141.17	19.75	195.97	115.38
7	N1Si2	141.17	19.75	289.72	173.08
8	N1Si3	141.17	19.75	383.47	230.76
9	N2Si0	211.76	29.54	12.66	-
10	N2Si1	211.76	29.54	200.16	115.38
11	N2Si2	211.76	29.54	293.91	173.08
12	N2Si3	211.76	29.54	387.66	230.76
13	N3Si0	282.35	39.48	16.92	-
14	N3Si1	282.35	39.48	204.42	115.38
15	N3Si2	282.35	39.48	298.17	173.08
16	N3Si3	282.35	39.48	391.92	230.76

3. Result

3.1 Effect of different Levels of Nitrogen and Silica on Growth Parameter of Rice

The data presented in table 5, showed the statistical variations in the plant height at various stages of the crop with the application of varying levels of nitrogen as well as silicon. The application of different levels of nitrogen showed significant result with respect at 30 DAT. The maximum plant height of rice (71.32 cm) was recorded in the N_3 treatment in which 80 per cent RDN through KAB was applied. Similarly the application of different levels of silica showed significant results with respect to plant height of rice. The maximum plant height of rice (71.23 cm) was recorded in the Si_3 treatment in which 100 kg Si ha^{-1} was applied. The height of rice was increased gradually from 48.03 to 76.00 cm in all treatment combinations.

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Table 5. Effect of different levels of nitrogen and silica on plant height at 30 DAT, 60 DAT and at harvest

Treatment Level	Plant height (cm)		
	30 DAT	60 DAT	At Harvest
N0	59.98	100.41	101.83
N1	66.77	110.97	111.27
N2	70.02	117.49	118.38
N3	71.32	118.81	120.03
Mean	67.02	112.17	112.88
SE	1.13	1.19	1.38
CD	3.25	3.44	3.99
Si0	62.24	106.25	107.42
Si1	65.33	110.32	111.95
Si2	69.27	114.99	115.22
Si3	71.23	116.12	116.93
Mean	67.02	112.17	112.88
SE	1.13	1.19	1.38
CD	3.25	3.44	3.99

The interaction effect was found statistically not significant. In the interaction effect, the maximum height of plant (76.00 cm) was recorded N_3Si_3 treatment combination in which 80 per cent RDN through KAB with potassium silicate @ 100 kg ha^{-1} was applied. At 60 DAT and harvest, similar results were observed. The application of different treatment combinations did not reach the level of significance with respect to height of plant. The maximum plant height at 60 DAT (118.81 cm) and at harvest (120.03 cm) was recorded in the N_3 treatment in which 80 per cent RDN through KAB was applied.

The application of different levels of silica showed significant results irrespective of plant height of rice. The maximum plant height was recorded at 60 DAT and harvesting stage (116.12 and 116.93 cm) in the Si_3 treatment where Si was applied @ 100 kg ha^{-1}.

3.2 Number of Tillers

The data depicted in table 6, showed the variations in tillering of the crop at various stages with the application of varying levels of nitrogen as well as silicon. The application of different levels of nitrogen showed significant results irrespective of number of tillers. The highest number of tillers was recorded at 30 DAT, 60 DAT and harvest (8.02, 10.78 and 9.82) in the N_3 treatment in where 80 per cent RDN through KAB was applied. The maximum number of tillers at 30 DAT (7.95), 60 DAT (10.70) and at harvest (9.52) was recorded in the Si_3 treatment where Si was applied @ 100 kg ha^{-1}. It was observed that the application of different treatment combination did not reach the level of significance at all growth stages of rice with respect to number of tillers. The number of tillers decreased at harvest stage than the 60 DAT because at 60 DAT measured tillers what is observed *i.e.* not complete panicle stage but at the time of harvest measured the effective tillers per hill *i.e.* panicle are developed so these decreasing the number of tillers at harvest than 60 DAT.

Table 6. Effect of different levels of nitrogen and silica on Number of tillers 30 DAT, 60 DAT and at harvest

Treatment Level	No of tillers		
	30 DAT	60 DAT	At Harvest
N0	5.62	7.70	6.85
N1	7.77	9.80	8.67
N2	7.80	10.17	9.45
N3	8.02	10.78	9.82
Mean	7.30	9.61	8.70
SE	0.27	0.19	0.23
CD	0.77	0.56	0.66
Si0	6.65	8.88	8.02
Si1	7.12	8.98	8.22
Si2	7.48	9.89	9.03
Si3	7.95	10.70	9.52
Mean	7.30	9.61	8.70
SE	0.27	0.19	0.23
CD	0.77	0.56	0.66

3.3 Effect of Different Levels of Nitrogen and Silica on Yield of Rice

Application of different levels of nitrogen significantly influenced the grain and straw yield of rice has been showed in the table 7. The significantly highest grain yield (35.99 kg ha^{-1}) and straw yield (48.24 kg ha^{-1}) were recorded with application of 80 per cent RDN through KAB. Application of potassium silicate @ 100 kg ha^{-1} produced the highest grain yield (31.21 kg ha^{-1}) over the different levels of silica but straw yield did not reach the level of significance. The application of different treatment combinations did not reach the level of significance with respect to grain and straw yield. There was huge difference between control and silica treated plot because at grain filling stage, pollen were washed out due to the high rainfall during 34 to 38 meteorological weak of 2017 but higher percentage of grain filled observed in silica treated plot. In case of, the application of different levels of silica as well as in-

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teraction effect of different levels of nitrogen and silica showed non-significant results regarding straw yield of rice.

Table 7. Effect of different levels of nitrogen and silica on grain and straw yield of rice

Treatment Level	Grain Yield (q ha-1)	Straw Yield (q ha-1)
N0	18.50	34.83
N1	23.02	37.67
N2	25.69	40.38
N3	35.99	48.24
Mean	25.80	40.28
SE	2.22	2.25
CD	6.41	6.49
Si0	19.50	37.49
Si1	24.86	38.73
Si2	27.63	41.21
Si3	31.21	43.69
Mean	25.80	40.28
SE	2.22	2.25
CD	6.41	NS

4. Discussion

The plant height of the rice crop increasing with increasing nitrogen fertilizer levels [16] and it also increased with the age of the crop. It was also observed from this research that, silicon application increases plant height because leaves and stem become more erect, thus reducing self-shading and increasing photosynthesis rate, especially under conditions of high population densities and high dose of nitrogen (Ghanbhari 2011). Analogous verdicts existed informed regarding the response of silica application on rice crop [6,10,26]. This higher nitrogen application which influence obligate augmented the chlorophyll formation and enhanced photosynthesis and there by amplified the plant height and total of tillers per unit area leading to the production of high dry matter. Upturn in nitrogen might have assisted in grander photosynthesis and nitrogen being a basic constituent of protoplasm and chloroplast might have inspired meristematic growth and thus increased the several growth parameters of semi-dry rice [24]. Parallel results were too obtained by the silica application regarding yield of paddy [1,8,20,26]. The application of N and P fertilizers considerably increased total Si uptake by rice [31]. Incorporation of 2, 4 and 6 t CSS ha^{-1} with PU+SSP caused a significant rise in silicon uptake. They likewise observed that total uptake of N, P, Ca and Mg increased by rice as the dose of the CSS increased with N and P. The increase in grain yield influence remain due to more efficient use of solar radiation, moisture and nutrients since silicon makes the rice plant more erect [23].

An experiment was conducted [17] in which it was obtained the various yield due to use of different levels of Si (0, 483, 966, 1448 kg ha^{-1} of Si as calcium silicate) in different soils of Karnataka Mangalore (Typic Kandiustults), Mudigere (Paleustults) and Ponnampet (Ustic Palehumults) ranges from 25.4 to 40.9 Kg pot^{-1} and the rate of increase in yield ranges from 1.1 to 16.0 kg pot^{-1}.

The higher grain yield and straw yield were recorded similar to the finding of [7]. It may be due to higher N rates, which primarily increased the chlorophyll concentration in leaves and there by higher photosynthetic rate and ultimately plenty of photosynthates available during grain development [14].

The grain yield reaction to silicon application could be there in line towards increased leaf erectness, diminished mutual shading affected by dense planting and high nitrogen application, nitrogen upsurges susceptibility to various diseases in rice [26,35]. Silicon fertilizer application decreased blank spikelet number in rice and that created plant not to have enough carbohydrates to fill up all spikelet produced as the silicon fertilization level increased contribution to decline the number of blank spikelet and to surge filled spikelet percentage [7]. Si fertilization increased [1,19] rice straw yield and grain yield [22].

The concentration of nitrogen deteriorated in straw with age and its content was least at harvest. Growth wise alterations in nitrogen content as affected by nitrogen application [13,15,26,36]. The silicon application has potential to elevate optimum nitrogen degrees due to its synergistic effect, silicon fertilized plant might have added maximum benefit of adequate nitrogen available because it reduced harmful effect and stimulated photosynthesis [9].

5. Conclusion

It is concluded that the application of 80 per cent RDN through Konkan Annapurna Briquettes (KAB) with Silica @ 100 kg ha^{-1} which was applied at 7 days after transplanting between four hills was found promising to enhance the rice yield of Ratnagiri-24 variety in lateritic soils of Konkan during *Kharif* Season. The application of nutrients in the form of Konkan Annapurna Briquettes along with the application of silica at a certain level can

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reduce the recommended dose of fertilizer to the extent of 20 per cent during *kharif* season in Konkan region of Maharashtra without hampering the yield level of the same crop.

6. Summary

The research trial was conducted with the interest of the increasing the availability of the nutrients to the rice crop under submerged condition. Because of the lower availability of the nitrogen in lateritic soils of *konkan* region we tried to point out the relation between silica and nitrogen related to the rice crop. The research was completed with the proper aims and objectives with the help of my research guide Dr. N. B. Gokhale, Deputy Director of Research, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

Conflict of Interest

We all authors declare that we don't have any conflict of interest.

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