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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(1): 208-214

www.thepharmajournal.com
Received: 07-11-2021
Accepted: 09-12-2021

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Growth and development of paddy due to deferent amendments and nutrient management practices in sodic soil

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Abstract
Retrieving of productive potential of sodic soil is very essential to effective utilization of very important natural resource, soil. In this connection, field experiment was conducted at College of Agriculture, VC Farm, Mandya Karnataka to know the response of paddy to different amendments and nutrient management practices in sodic soil. In the investigation three types of nutrient management practices such as recommended dose of fertilizer (RDF), soil test crop response (STCR) and site specific nutrient management (SSNM) were used along with different amendments *viz*., gypsum, pressmud and different levels of mangala setright. The results of investigation revealed that application of fertilizers as per th RDF was found superior followed by SSNM and STCR approaches with respect to growth and development of paddy, though the results obtained were not significant among them. Application of pressdmud @ 100% GR recorded higher plant height, number of tillers, length of panicle, grains per panicle, grain and straw yield compared to no amendment control and other amendment treatments. Whereas number of panicles and productive tillers per hill were found higher in setright @ 600 kg ha-1 treatment. Among the interaction effect, fertilizer application based on RDF approach along with pressmud @ 100% GR as an amendment has significantly increased the grain and straw yield of paddy compared to many of other combinations which is closely followed by SSNM+ Pressmud @100%GR. Thus application of RDF with pressmud @100% GR or Mangala setright @ 400 or 600 kg ha-1 was economical in paddy production under sodic soil.

Keywords: recommended dose of fertilizer (RDF), soil test crop response (STCR), site specific nutrient management (SSNM), mangala setright, pressmud, gypsum

Introduction
India, with 130 crore population require to produce enormous quantity of food grains in limited available land. There are various constraints even in available land for agriculture production, such as soil erosion, salt accumulation, acidity, low fertility and deviated surface characteristics etc,. Amongst these the sodic soil is also a major one, that exhibits poor structural stability due to dispersion of clay [1] and excess accumulation of carbonates and bicarbonates of sodium, make this soil more worse, which intern reduce the productivity of that land by hindering the nutrient acquisition by plants due to disruptive action of excessive sodium [2]. Success of any crop in such soil depends on the quantity and availability of nutrients. The plant growth is either depressed or entirely prevented due to excessive build-up of salinity and/or alkalinity in the soil resulting in poor crop yields [3]. Sufficient total quantities of essential nutrients in salt-affected soil does not guarantee the availability of these nutrients to growing plants for optimum crop yields because of deviated unfavorable characteristics of these soils, toxic elements and ionic imbalance in soil and plant system. Thus judicious management of plant nutrients in these soils is the same as that of their reclamation. Several approaches being used to recommend fertilizers for rice such as RDF, STCR and SSNM and proved that they are the best approaches to recommend fertilizer for crops. However, the applied fertilizer efficiency can be achieved with reclamation techniques which change the soil environment favorable for growth of the plant [4]**.** It has been reported that addition of acid formers and calcium to high sodium degraded soil, improve the soil health for some extent. Various amendments like gypsum, elemental sulphur, acids, pressmud and farm yard manure (FYM) may be used for reclamation of these soils [5] and also replenish the nutrient pool in soil. The use of gypsum as a source of Ca^{2+} is a well established practice for the amelioration and management of sodium saturated

water/soils [6]. Press mud contains valuable nutrients in organic form besides this it will be an excellent soil ameliorant [7]. These Amendments with calcium ion, that dissociates by water or increase the dissolution of native calcium ion work in such a way that, replace the sodium ion in clay complex of soil and replenish the health of sodic soil.

Rice is most predominant crop which can sustain under various soil environments; it is true with soil containing high sodium. The productivity of sodic soil can be improved by using salt tolerant rice varieties [8]**.** Using general recommendations for NPK fertilizers has resulted in soil fatigue, proving their decreased efficiency, and thus requires upward refinement and proper balance for macro and micronutrients**.** There are many evidences are available, that use of various balanced nutrient supply module such as RDF, SSNM, STCR [9]**,** DRISS in rice crop for profitable production in normal soil. A scientific report said that 47q/ha of grain yield was obtained in paddy with STCR approach of 50q/ha targeted yield [10]. Whereas Use of SSNM to manage fertilizer N, P, and K has been shown to effectively increase yield and net income in researcher-managed trials across rice-production areas in Asia [11]. The effective nutrient management in any crop is key phenomenon to obtain the economical yield in wide variety of soil which helps to meet the production need of the country and also to get higher efficiency of fertilizer use. Thus the combination of different nutrient management approaches with amendments were tried to know the potential response of paddy under sodic environment through this investigation.

Material and Methods

The field experiment was performed at College of Agriculture V C Farm Mandya UAS Banaglore, Karnataka, India. The geological position of experimental site was 76°82'05" E longitude and 12°58'06" N latitude with 705 meters above mean sea level. To analyze the characteristics of filed, initial sample was drawn at 0-15 cm and analyzed for various parameters according to standard analysis procedure. The soil of the experimental plot was sandy clay loam texture class with alkaline in reaction (pH 8.96) and contained soluble salt (1:2.5) of 1.22 dS m-1. The organic carbon, available nitrogen content was high, while it was medium in available P2O5, K2O and sulphur. The exchangeable calcium, magnesium and sodium content of soil was 12.62, 2.5 and 5.53 m eq 100 g-1, respectively. The ESP of soil was 22.59. On the basis of pH, EC and ESP values it was classified as sodic soil. The DTPA extractable micronutrient content *viz*., zinc, iron, copper and manganese were found low in status.

Experimental details and Characteristics of amendments:

The experiment was performed in split plot design with 21 treatments combination. The three main plot treatments were nutrient management practices and seven sub treatment of different amendments. Each treatment was replicated thrice. Details of treatment imposed are as follows:

Main Treatments: M1: Recommended dose of fertilizer (RDF) with dose of 125-62.5-50 kg ha-1 of N, P2O5, K2O, M2: Soil test crop response (STCR) with dose of 15.25:68:5.57 kg ha-1 N, P2O5, K2O. Required quantity of K fertilizer was very low hence 50 per cent of recommended dose was applied as per the AICRP on STCR rules. M3: Sight specific nutrient management (SSNM) with dose of 100.5:56:150 kg ha-1 of N, P2O5, K2O. Recommended dose of potassium as per SSNM approach was high so that 30 per cent less than the actual dose were applied.

Sub Treatments: T1: No amendments, T2: Gypsum @100% GR T3: Pressmud @100% GR, T4: 200 kg ha-1 setright, T5: 400 kg ha-1 setright, T6: 600 kg ha-1 setright, T7: 800 kg ha-1 setright. Salt tolarent paddy variety of IR-30864 was used in this investigation. 32 days old seedling was transplanted to main field with spacing of 20x10cm. Further crop care was carried as per the standard package of practice uniformly to all treatments. Three types of amendments are used *viz*. gypsum, pressmud and setright. Gypsum is age old chemical ameliorant for sodic soil which contain 20.70% of calcium and pH of 4.22 where as pressmud has a calcium content of 5.56% , pH 6.75 and also quite good amounts of available nutrient content. Apart from this there are many commercial soil conditioners are available in marker at lower cost. Among those Mangala Setright, manufactured by Mangala Chemicals and Fertilizers limited Bengaluru was used which contains 15% of calcium. All amendments are applied in advance (15days) ie before transplanting in order to provide sufficient incubation period.

Plant part used for data collection and analysis

As per the institutional standers five hills from net plot of each treatment in each replication were selected at random and labeled for the purpose of recording various growth and yield parameters. The plant height (Measured from ground level to growing tip) and number of tillers were recorded at 30, 60 days after sowing and at the time of harvest. In yield parameters such as number of panicles, length of panicles, grains per panicle and test weight was collected at harvest and computed average. Grain and straw yield was recorded for whole plot and converted to hectare basis yield. The date obtained was subjected to average and analyzed using split plot statistical design tool for measurement of mean, standard error, and variance $P \leq 0.05$ as significant.

Results

Growth parameters

The data presented in Table.1on plant height of paddy reveals that the effect of different nutrient management practices on plant height was not significant. However application of RDF produced taller plants at 30, 60 DAP and at harvest (50.93, 68.70 and 71.25 cm, respectively) as compared to STCR and SSNM treatment. Whereas, among the amendments tried application of pressmud @ 100% GR recorded significantly taller plants at all growth stages *viz*., 30, 60 DAP and at harvest (50.44, 71.54 and 73.08 cm, respectively). But it was on par with that recorded due to application of setright @ 400 kg ha-1 (49.74, 69.21 and 72.63 cm, respectively) and setright @ 600 kg ha-1 (50.81, 69.43 and 73.00 cm, respectively). The interaction effect was not significant except at 30 DAP. Thus the maximum plant height of 56.13 cm was recorded in RDF+ setright @ 600 kg ha-1 treatment. Even if, under non significance, taller plant height of 76.11cm was registered in combination treatment of RDF+Setright 600kg/ha followed by 74.80 cm in SSNM+pressmud @100% GR at the time of harvest.

Table 1: Plant height (cm) of paddy as influenced by application of different amendments and nutrient management practices

Treatments	30 DAP				60 DAP				AT HARVEST			
	M1	M2	M3	MEAN	M1	M2	M3	MEAN	M1	M2	M3	MEAN
T1	41.47	35.93	38.83	38.74	53.87	50.70	59.80	54.79	60.43	49.40	65.10	58.31
T2	49.47	44.47	46.87	46.93	68.77	63.20	69.60	67.19	70.93	66.27	73.80	70.33
T3	52.20	47.87	51.27	50.44	72.36	70.37	71.90	71.54	72.03	72.40	74.80	73.08
T4	51.80	45.27	46.63	47.90	69.17	42.77	67.37	59.77	72.67	72.07	69.17	71.30
T5	52.97	48.90	47.37	49.74	71.23	69.47	66.93	69.21	72.30	73.80	71.80	72.63
T6	56.13	48.27	48.03	50.81	73.53	65.57	69.20	69.43	76.11	71.10	71.80	73.00
T7	52.47	47.20	41.33	47.00	71.97	69.17	65.70	68.94	74.30	72.57	70.77	72.54
MEAN	50.93	45.41	45.76		68.70	61.60	67.21		71.25	68.23	71.03	
	M	T	M xT		M	T	M xT		M	T	M xT	
S.Em±	2.06	0.77	1.34		2.70	2.82	4.88		4.01	2.36	4.09	
CD(p=0.05)	NS	2.21	3.83		NS	8.08	NS		NS	6.78	NS	

Nutrient management practices: M1: Recommended Dose of Fertilizer M2: Soil Test Crop Response M3: Site Specific Nutrient Management Amendment Application: T1: No amendment control T2: Gypsum @ 100% GR T3: Pressmud @ 100% GR T4: Setright @ 200 kg ha-1 T5: Setright @ 400 kg ha-1 T6: Setright @ 600 kg ha-1 T7: Setright @ 800 kg ha-1

Tillers are the major growth parameter of paddy which has more contribution on economical yield. The results revealed that number of tillers per hill at 30, 60 DAP and at harvest (Table .2) did not vary significantly due to different nutrient management practices. But RDF recorded more number of tillers (8.95, 12.57 and 13.48, respectively). However, addition of pressmud @ 100% GR recorded significantly more number of tillers at different growth stages *viz.*, 30, 60 DAP and at harvest (9.11, 13.22 and 13.78, respectively) compared to the no amendment control (5.67, 8.22 and 9.00 respectively). But it was on par with setright applied @ 400 kg ha-1 (8.89, 12.00, and 13.56 respectively) and setright applied @ 600 kg ha-1 (8.89, 12.44, and 13.78, respectively). Application of Setright 400 kg ha-1 and setright 600 kg ha-1 are at par with each other. Further application of gyspsum @100 GR also produced significant more number of tillers (8.78, 12.44 and 13.44 respectively) compared to control at all time interval. But results obtained in Gypsum @100% GR is quantitatively less compared to above said treatments but is on par with all treatment. The interaction of nutrient management practices and amendments on number of tillers showed non-significant effect at all growth stages. However, higher number of tillers was observed in RDF+setright 400kg/ha (15.67) at harvest.

Table 2: Number of tillers per hill of paddy as influenced by application of different amendments and nutrient management practices

Treatments	30 DAP				60 DAP				AT HARVEST			
	M1	M2	M3	MEAN	M1	M2	M3	MEAN	M1	M2	M3	MEAN
T1	04.67	06.33	06.00	05.67	07.67	08.67	08.33	08.22	08.00	09.67	09.33	09.00
T2	11.00	07.33	08.00	08.78	14.67	11.67	11.00	12.44	14.67	13.00	12.67	13.44
T3	09.33	09.33	08.67	09.11	13.67	14.00	12.00	13.22	14.33	14.00	13.00	13.78
T4	09.67	08.33	09.00	09.00	13.67	11.67	12.67	12.67	14.33	12.33	12.33	13.00
T5	10.33	08.67	07.67	08.89	13.33	12.00	10.67	12.00	15.67	13.00	12.00	13.56
T6	08.33	08.00	10.33	08.89	11.67	11.67	14.00	12.44	13.67	13.00	14.67	13.78
T7	09.33	08.00	09.33	08.89	13.33	11.67	12.33	12.44	13.67	12.33	12.33	12.78
MEAN	08.95	08.00	08.43		12.57	11.62	11.57		13.48	12.48	12.33	
	M	T	M xT		M	T	M xT		M	T	M xT	
S.Em±	0.54	0.56	0.98		0.56	0.53	0.91		0.52	0.50	0.87	
CD(p=0.05)	NS	1.62	NS		NS	1.51	NS		NS	1.44	NS	

Nutrient management practices: M1: Recommended Dose of Fertilizer M2: Soil Test Crop Response M3: Site Specific Nutrient Management Amendment Application: T1: No amendment control T2: Gypsum @ 100% GR T3: Pressmud @ 100% GR T4: Setright @ 200 kg ha-1 T5: Setright @ 400 kg ha-1 T6: Setright @ 600 kg ha-1 T7: Setright @ 800 kg ha-1

Yield parameters

The number of panicles per hill did not vary significantly due to nutrient management practices. But more number of panicles per hill (11.24) was recorded in RDF compared to SSNM (10.81) and STCR (10.62) approach of nutrient management. Among the influence of different amendments, application of setright at 600 kg ha-1 increased the number of panicle per hill significantly to 12.44 over no amendment control (7.00). But it was on par with treatment to which pressmud @ 100% GR (12.11) and setright @ 400 kg ha-1 (12.00) was applied. Further the number of panicles recorded due to application of gypsum @ 100% GR (10.67) was statistically lower than all other treatment except no amendment control. The interaction effect was non-significant. However more number of panicle per hill 13.00 was recorded in RDF + pressmud @ 100% GR followed by 12.67 in RDF+ setright @ 400 kg ha-1 treatment and 12.33 in SSNM+ Setright 600 Kg/ha (Table.3).

The data are presented in Table 3 reveals that, the length of panicle did not vary significantly due to application of nutrients by different approaches. Though, higher panicle length was observed in SSNM (16.87 cm) compared to RDF (16.32 cm) and STCR (16.04 cm). Among the different amendments, application, setright @ 400 kg ha-1 produced highest panicle length (17.34 cm) over no amendment control (14.12 cm) but it was on par with those observed due to application pressmud @ 100% GR (16.88 cm). Length of panicles produced in pressmud@100% GR treatment is at par with Gypsum @100%GR (16.50cm). where in average length of panicle produced due to setright 400 kg ha-1 is significantly superior compared to Gypsum @100% GR. The interaction effect was not significant. However higher panicle length of 18.03 cm was recorded in STCR+ setright @ 400 kg ha-1 followed by 17.66 cm in SSNM+ Setright @600 Kg/ha and RDF+Pressmud @100%GR (17.33cm).

The difference in test weight due to application of amendments and nutrient management practices is presented in Table 4. Among the different nutrient management practices, RDF treatment recorded significantly higher test weight (20.51 g) compared to STCR and SSNM (19.39 and 19.21 g, respectively) treatments. The effect of amendments on test weight was significant. Maximum test weight of 20.86 g was recorded in 400 kg ha-1 setright level compared to control (17.58 g) and other amendment treatment except T2 and T4 (20.41 and 20.35 g, respectively). The test weight due to interaction between amendments application and nutrient management practices was non-significant. However, maximum test weight of 21.33 g was recorded on application of SSNM with setright @ 400 kg ha-1.

The effect of nutrient management practices and application of amendments on number of grains per panicle was significant (Table.4). Significantly higher number of grains per panicle (90.24) was recorded in SSNM treatment compared to RDF (84.58) and STCR (81.77). whereas the data on number of grains per panicle recorded with STCR and RDF was at par with each other. Grains per panicle recorded in control and gypsum @ 100% GR was 59.36 and 85.24, respectively which increased significantly to 99.11 on application of press mud @ 100% GR. But it was on par with application of setright @ 400 and 600 kg ha-1 treatment (98.78 and 97.82, respectively). The highest grains per panicle (103.40) was recorded due to application of RDF+pressmud application @ 100% GR interaction which was statistically at par with setright @ 400 kg ha-1 with STCR and SSNM (100.00 and 100.20, respectively) approaches.

Table 3: Number of panicle per hill, length of panicle and productive tillers per hill of paddy as influenced by application of different amendments and nutrient management practices

Treatments	Number of panicles per hill				Length of panicle (cm)			
	M1	M2	M3	MEAN	M1	M2	M3	MEAN
T1	06.33	06.67	08.00	07.00	14.00	12.24	16.13	14.12
T2	11.00	10.33	10.67	10.67	16.36	16.18	16.97	16.50
T3	13.00	11.67	11.67	12.11	17.33	15.91	17.39	16.88
T4	11.67	11.33	10.33	11.11	16.95	16.26	16.70	16.64
T5	12.67	11.33	12.00	12.00	16.35	18.03	17.65	17.34
T6	12.67	12.33	12.33	12.44	16.43	16.51	17.07	16.67
T7	11.33	10.67	10.67	10.89	16.80	17.12	16.15	16.69
MEAN	11.24	10.62	10.81		16.32	16.04	16.87	
	M	T	M xT		M	T	M xT	
S.Em±	0.61	0.52	0.90		1.02	0.60	1.04	
CD(p=0.05)	NS	1.48	NS		NS	1.73	NS	

Table 4: Grains per panicle and test weight of paddy as influenced by application of different amendments and nutrient management practices

Treatments	Grains per panicle				Test weight (g 1000 grains-1)			
	M1	M2	M3	MEAN	M1	M2	M3	MEAN
T1	054.27	061.27	062.53	059.36	1910	17.32	16.33	17.58
T2	089.27	068.27	098.20	085.24	20.16	20.28	20.80	20.41
T3	103.40	095.53	098.40	099.11	21.23	19.28	17.89	19.47
T4	072.53	072.00	084.93	076.49	20.81	20.21	20.03	20.35
T5	094.00	100.00	102.33	098.78	20.92	20.33	21.33	20.86
T6	097.47	095.80	100.20	097.82	20.86	19.23	18.36	19.48
T7	081.13	079.53	085.07	081.91	20.49	19.11	19.71	19.77
MEAN	084.58	081.77	090.24		20.51	19.39	19.21	
	M	T	M xT		M	T	M xT	
S.Em±	1.39	1.45	2.51		0.34	0.38	0.66	
CD(p=0.05)	5.46	4.15	7.19		1.32	1.10	NS	

Nutrient management practices: M1: Recommended Dose of Fertilizer M2: Soil Test Crop Response M3: Site Specific Nutrient Management
Amendment Application: T1: No amendment control T2: Gypsum @ 100% GR T3: Pressmud @ 100% GR T4: Setright @ 200 kg ha-1 T5: Setright @ 400 kg ha-1 T6: Setright @ 600 kg ha-1 T7: Setright @ 800 kg ha-1

Grain and straw yield

The data on grain yield and straw as influenced by different amendments application and nutrient management practice are presented in Table.4. Application of NPK by different approaches significantly increased the grain yield of paddy. Significantly superior yield of 2.27 t ha-1 was registered in RDF as compared to STCR (2.15 t ha-1) and SSNM (2.11 t ha-1). Whereas higher straw yield of 5.78 t ha-1 was recorded in SSNM compared to RDF (5.22 t ha-1) and STCR (5.22 t ha-1) practices. The grain yield obtained due to STCR treatment for target yield of 5.00 t ha-1 and SSNM was on par with each other.

Addition of different amendments increased the grain and straw yield of paddy significantly (Table.4). The grain yield of paddy in control was 1.23 t ha-1 which increased significantly to 2.59 t ha-1 due to application of pressmud @ 100% GR but it was statistically at par with those recorded in setright 400 kg ha-1and setright 600 kg ha-1 (2.46 and 2.43 t ha-1, respectively). However grain yield recorded in T2, T4 and T7 (2.21, 2.09 and 2.23 t ha-1, respectively) was significantly lower than that recorded with application of pressmud @ 100% GR and setright 400 kg ha-1. Mean while significant increase in straw yield (6.04 t ha-1) was recorded in treatment receiving pressmud @ 100% GR compared to control (3.71 t ha-1) but it was on par with setright applied at 400 kg ha-1 (5.91 t ha-1). Among different levels of Setright, 400 Kg ha-1 ha produced highest grain and sraw yield compared to other level.

Table 5: Grain yield, straw yield and B:C Ratio of paddy as influenced by application of different amendments and nutrient management practices

Treatments	Grain yield (t ha-1)				Straw yield (t ha-1)				B:C ratio			
	M1	M2	M3	MEAN	M1	M2	M3	MEAN	M1	M2	M3	MEAN
T1	1.18	1.15	1.36	1.23	2.90	3.60	4.63	3.71	0.64	0.69	0.77	0.84
T2	2.15	2.22	2.28	2.21	6.13	4.73	5.83	5.57	1.02	1.03	1.03	1.20
T3	2.93	2.45	2.40	2.59	6.23	5.57	6.33	6.04	1.21	1.07	1.01	1.26
T4	2.35	2.08	1.85	2.09	4.83	5.43	5.57	5.28	1.17	1.14	1.01	1.30
T5	2.14	2.76	2.47	2.46	5.60	6.20	5.93	5.91	1.06	1.39	1.17	1.42
T6	2.90	2.21	2.17	2.43	5.40	5.53	6.23	5.72	1.29	1.08	1.02	1.32
T7	2.27	2.17	2.27	2.23	5.47	5.50	5.95	5.64	1.01	1.01	1.00	1.17
MEAN	2.27	2.15	2.11		5.22	5.22	5.78		1.21	1.22	1.13	
	M	T	M xT		M	T	M xT					
S.Em±	0.03	0.06	0.11		0.09	0.18	0.32					
CD(p=0.05)	0.13	0.18	0.30		0.35	0.52	0.91					

Nutrient management practices: M1: Recommended Dose of Fertilizer M2: Soil Test Crop Response M3: Site Specific Nutrient Management Amendment Application: T1: No amendment control T2: Gypsum @ 100% GR T3: Pressmud @ 100% GR T4: Setright @ 200 kg ha-1 T5: Setright @ 400 kg ha-1 T6: Setright @ 600 kg ha-1 T7: Setright @ 800 kg ha-1

The interaction of amendments application and nutrient management practices had significant effect on grain yield of paddy. The highest grain yield of 2.93 t ha-1 was registered due to RDF + pressmud @ 100% GR but it was on par with RDF + setright @ 600 kg ha-1 (2.90 t ha-1). Where in application of STCR and SSNM with Setright 400kg ha-1 produced significantly higher yield (2.76 and 2.47 t ha-1 respectively) compared to control but statistically lower than RDF + amendment combination. Similarly, significantly higher straw yield of 6.33 t ha-1 was recorded due to application of nutrients on SSNM approach + pressmud @ 100% GR followed by STCR+Setright 400 kg ha- 1(6.20 t ha-1). Among all interaction RDF +pressmud was on par with RDF+Setright 600 kg ha-1

B:C Ratio

Application of fertilizer based on STCR approach produced higher B:C ratio of 1.22 compared to RDF (1.21) and SSNM (1.13). Among the amendment treatments, gypsum @100% GR and pressmud @100% GR recorded B:C ratio of 1.20 and 1.26, respectively and maximum B:C ratio was recorded due to application of setright @400 kg ha-1 (1.42). B:C ratio due to interaction was highest in treatment with application of STCR+ setright 400 kg ha-1(1.39) compared to all other combinations (Table.5)

Discussion

The growth parameters observed in different nutrient management practices was not significant, however, the increase in plant height and number tiller recorded in RDF treatment may be due to higher dose of fertilizers applied compared to others. The fertilizers applied using STCR and SSNM practice was better for normal soil situation. Application of preesmud @100% GR produced highest plant height and number of tillers but it was on par with Setright 400kg ha-1. The improvement in growth parameters due to application of different amendments might be due to reduction in soil pH and ESP due to supply of calcium through these amendments. Amendments reduced the problem of sodicity which in turn increased the availability of nutrients. Thus better supply of essential nutrients which are required for plant growth might be the reason for better growth in treated plot than no amendment control [12]. It might also be attributed to soluble calcium that could reduce Na+ binding to cell wall and plasma membrane and improve the integrity and function of plasma membrane thus it alleviate the toxic effect of sodium ion on rice growth [13]**.** Highest rate of growth in pressmud treated plot might be attributed to, addition of nutrients through pressmud as it contained essential nutrients in addition to supply of calcium and sulphur for reclamation [14]. Mean while on par growth attributes also observed in setright 600kg ha-1 treatment which may be due to reduction of sodicity by calcium ion might have created favorable soil condition for the absorption of available nutrients. Similar results were also been reported that application of pressmud recorded superior growth parameters [15]. Similarly gypsum application @ 100% GR improved the growth components [16, 4] in sodic soil which support this study.

The yield components produced in RDF treatment were higher compared to SSNM and STCR due to observed improvement in growth parameters with higher dose of fertilizers in this treatment. Yield parameters such as number of panicles, length of panicles and test weight was significantly higher in treatment receiving setright 400 kg/ha but it was on par with press mud applied at 100% GR. whereas grain per panicle was found highest in pressmud @ 100% GR and it was on par with setright @400 Kg ha-1. This improvement may be attributed to improved soil properties due to ameliorating action of seright and pressmud which channelized the continuous and controlled supply of nutrients throughout the crop growth period [17] which intern nursed for good growth of crop, further it advanced in superiority of yield components. Researcher reported that application of gypsum @ 100% GR significantly improved the yield parameters such as number of grains per plant, test weight, and length of panicle etc. [16] which also evident improvement in yield parameter in setright treatment as both gypsum and setright are source of calcium. Similarly application of pressmud along with 25% NPK recorded highest panicle length, grains per panicle and number of productive tillers of paddy [15] which clarifies that use of pressmud will be economical in increasing yield for the farmers especially in sodic soil**.**

The interaction effect of nutrient management practices along with application of different amendments did not vary significantly with respect of many yield and growth factors but higher than that recorded with just application of nutrients without amendments (control). It suggests that as it is sodic soil for the better utilization of applied nutrients the soil conditions needs to be corrected then only there will be improvement in the crop growth. Similarly, the higher values recorded in the combination of RDF and amendments might be attributed to application of higher quantity of nutrients through RDF as compared to other nutrient management approaches and being supply of nutrient from native pool as a consequence of reduced sodicity due to action of amendments. This resulted in better growth parameters which resulted in higher grains per panicle and other yield parameters.

The higher yield obtained due to application of RDF might be attributed to improvement in growth parameter and yield parameters such as number of productive tillers, panicle length and number of grains per panicle due to application of higher level of N through RDF than through STCR

and SSNM. It is well known fact that N is required for growth of plants, tillering and chlorophyll synthesis [18] which in turn resulted in higher grain yield. Low yield of paddy in STCR treatment may be due to low fertilizer rate and also equation used for computing fertilizer rate was developed for normal soil. In both STCR and SSNM comparatively low yield was registered due to less rate of fertilizer application but difference in yield was very meager. It was also observed by many workers that higher N level is required for better growth and yield of rice grown in salt affected soil than the rice grown under normal soils (125 kg v/s 100 kg N ha-1) [19, 20] and also The application of nitrogen @ 120 kg ha-1 increased the yield than applied @ 90 kg ha-1 [21] which clearly establishes that high nitrogen required for good growth in high pH soils.

The grain and straw yield obtained with pressmud @100% GR was on pr with Setright 400kg ha-1 but effect of gypsum application on yield was statistically lower compared to both the treatments. In comparison, setright performed more superiorly compared to gypsum in sodic soil with respect to grain and straw yield. It may be attributed to more dissolution of setright in water compared to gypsum may added advantage in quick correction of sodicity of soil which advanced the good growth and yield. If comparison placed between Pressmud and Inorganic amendment, pressmud exhibited

highest yield compared to all. This may be due to extra addition of nutrients to soil [22] upon

decomposition of pressmud besides correcting the sodicity of soil by calcium ion and organic acids released during decomposition. The low yield obtained in control plot clearly demonstrates the effect of excess sodium on exchange complex on yield, while significantly higher grain yield was obtained with amendments might be attributed to decrease in pH and ESP of sodic soil upon incorporation of amendments [23]**,** which might have helped in better nutrient utilization by crop. Increase in yield may be also due to, Sodic soils subjected to reclamation are improvised in supply of nutrients which evident better availability of nutrients for crop in sodic soil [12]. Similar low yield of paddy grown in unamended sodic soils have been documented by finders [24, 25] However, recorded higher yield due to application of amendments in sodic soils [15, 26] which improved the soil physical and chemical environment responsible for good growth and development of crop. Similar results are also obtained, where the application of pressumud at 10t/ha, exhibited significant increased yield over control [27] under sodic environment Among interaction RDF+ Presssmud@100% GR produced highest grain yield which was onpar with RDF+ Setright 600kg ha-1. The higher yield may be attributed to improvement in soil properties due to addition of pressmud followed by application of nutrients. one of the investigation found that application of RDF+ press mud at10 t/ha produced significant yield of 3.27t/ha over farmer practice [28]. The more rate of application and improved availability of nutrients due to improvement in sodicity enhanced the growth and yield parameters of paddy, as result of improvement in these parameters higher grain and straw yield. Low yield in STCR and SSNM amendment combination may be due to less quantity of fertilized received compared to RDF but comparative yield was obtained with STCR and SSNM + amendment combination demonstrates its good feasibility in sodic soil.

Acknowledgement

Authors of this paper are heartily thankful to University of Agricultural Sciences Bangalore and College of Agricultural Sciences VC Farm Mandya for providing all required resources and timely support to smooth conduct of research. And also we express our gratitude to Mangala Fertilizers and Chemicals Limited Bangalore for providing amendment called Mangala Setright for this research

Conclusion

The present investigation revealed that, application of amendments would improve the soil properties required for plant growth. Application of press mud @100%GR along with recommended dose of fertilizer is very effective in promoting growth and development of paddy which directly related to higher grain yield. While in place where the pressmud is not available then, the better option is to use commercial soil conditioner such as Managal Setright at 400 or 600 kg ha-1 for improving sodic soil condition and to harvest economical produce.

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