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Influence of organic and inorganic amendments on growth, nutrient uptake of rice in tile end of V. C canal in Cauvery command area, Karnataka

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Abstract
Areas under tail end of Visveswarayya Canal, Cauvery command area, Karnataka indicated that soils were sandy clay in nature, alkaline in reaction (pH 7.61 to 8.20) with EC ranging from 0.43 to 1.1 dS m^{-1}. The soils were low organic carbon, medium nitrogen, high phosphorus, low potassium, high calcium, magnesium, sulphur and micronutrients. The sodium ion ranging from 0.85 to 0.98 cmol (p^+) $kg^{-1}$and exchangeable sodium percentage (ESP) from 4.40 to 6.10.Field experiment was conducted during *kharif* season 2017 at farmer's field in Hemmanahalli village, Maddur taluk, Mandya district to assess the growth and yield response to organic and inorganic amendments to alkaline soil. The experiment was laid out in a randomized complete block design with nine treatment combinations replicated thrice. The results revealed that the application of 100% NPK+ Green manure+ $ZnSO_4$+ Gypsum+ FYM recorded significantly higher grain (6266 kg ha^{-1}) and straw (6892 kg ha^{-1}) yield of rice, nutrient content and uptake followed by 50% NPK+ Green manure+ $ZnSO_4$+ Gypsum+ FYM as compared to POP and other treatments. Further, higher primary, secondary and micronutrient status in soil and decreased pH, EC, Na and ESP were recorded in the same treatment. The study clearly showed that in alkaline soils, Application of 100% NPK+ Green manure+ $ZnSO_4$+ Gypsum+ FYM is more beneficial in enhancing the crop yield, crop productivity as well as fertility of the soil.

Keywords: Alkaline soil, gypsum, green manure, paddy, FYM

Introduction
The world's population is continuously rising and the current projections indicate that the population is likely to increase from 6.9 billion people to 9.1 billion by 2050. As a result world food demand will surge and it is projected that food production will increase by 70 per cent in the world and 100 per cent in the developing countries. But intensive cultivation and irrigations are posing a threat to land and water resources, causing soil degradation. Soil alkalinity is a condition that results from the accumulation of soluble salts in the soil. The chief minerals in irrigation water are chloride, sulfate, bicarbonate, sodium, calcium, and magnesium. These minerals, present in the irrigation water, accumulates in the soil and cause problems. Sodium, bicarbonates, and chlorides are the three minerals that contribute most to soil salinity and alkalinity.

Paddy (*Oryza sativa*) is grown in different agro-eco systems. It occupies prime place among the food crops cultivated around the world and is grown in an area of 147 m ha with a production of 525 m t. About 90 per cent of rice grown in the world is produced and consumed in Asia. Among rice growing countries, India is the largest area (41.91 m ha) with a production and productivity of 89.1 million tonnes and 2.12 t ha^{-1} respectively. In Karnataka, rice is grown in an area of 1.48 m ha with an annual production and productivity of 3.69 million tonnes and 2.48 t ha^{-1}, respectively (Anon., 2012). Among the cereals, paddy can tolerate salinity/alkalinity to a moderate level and occupies the first and second position in terms of area and production, respectively.

Material and Methods
The study was conducted during *kharif* season 2017 at farmer's field in Hemmanahalli village, Maddur taluk, Mandya district, and situated at 12° 36' North latitude 77° 4' East longitude and at an altitude of 662 meters above mean sea level, located in Southern Dry Zone of Karnataka. The test crop was paddy with variety GNV-1089, the experiment were laid out in a randomized complete block design (RCBD) with nine treatment combination replicated thrice. The treatments were T_1= 100% NPK +FYM (POP), T_2= 100% NPK+ Green Manure, T_3 =50% NPK + Green Manure, T_4= 100% NPK + Green Manure+ZnSO4, T_5= 50% NPK + Green Manure +$ZnSO_4$, T_6= 100%NPK + Green Manure+$ZnSO_4$+Gypsum, T_7= 50%NPK +

Green Manure+$ZnSO_4$+Gypsum, T_8= 100%NPK + Green Manure+$ZnSO_4$+Gypsum+FYM, T_9= 50%NPK + Green Manure+$ZnSO_4$+Gypsum+FYM.

The effect of application of FYM, $ZnSO_4$ and Gypsum on physical and chemical properties of soil was determined for the samples collected after the harvest of the crop. Soil samples collected from each plot were air dried, passed through 2 mm sized sieve and analyzed for physical and chemical properties by adopting standard chemical analytical methods.

Yield parameters like grain and straw yield were recorded. Grains were separated by threshing the produce obtained from each plot and sun dried, winnowed and weighed. Grain yield per hectare was worked out from the grain yield per plot and expressed in quintal per hectare and Straw obtained from each plot was dried under the sun for ten days, weighed and expressed in quintal per hectare at harvest of the crop.

Statistical analysis: The analyses and interpretation of the data was done using the Fisher's method of analysis and variance technique as given by Panse and Sukhatme (1967) [5]. The level of significance used in 'F' and 't' test was 5 per cent probability and wherever 'F' test was found significant, the 't' test was performed to estimate critical differences among various treatment.

Results and Discussion

The soil of the experimental site was alkaline in soil reaction (pH of 8.2), non-saline (EC 1.1 dS m^{-1}) with organic carbon content of 3.0 g $kg^{-1}$and CEC 14.3 cmol (p^+) kg^{-1} with respect to available nutrient status soil were low in available N (313.6 kg ha^{-1}), high in available P (211.42 kg ha^{-1}) and medium in available K (123.78 kg ha^{-1}) status. Exchangeable Ca [12.82 cmol (p^+) kg^{-1}], Exchangeable Mg [3.89 cmol (p^+) kg^{-1}], Exchangeable Na (0.98 cmol (p^+) kg^{-1}), Available S (10.76 mg kg^{-1}). Available Fe, Mn, Cu, Zn and B contents were present in an appreciable amounts of 0.51, 9.99, 3.17, 1.04 and 0.51 mg kg^{-1}, respectively. The HCO_3^{-2} (531.7ppm), Cl^- (810.1 ppm), ESP (6.10) and CO_3 (ppm) in the soil sample was not detected (Table 1).

Effect of organic and inorganic amendments on growth and yield parameters

The increased growth and yield attributes in paddy might be due to the combined application of gypsum and FYM along with RDF which might have enhanced the soil physical properties and better dissolution of nutrient element which favoured increasing in the yield attributes. In addition, a better supplementation of nutrient from organic and inorganic amendments might have increases the cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and increased nutrient absorption by increased root activity leading to better growth and development of the crop, crop height and number of tillers per hill (Table 2). Increased fertile panicles, number of grains per panicle and test weight (Table 3) and all this led to increased grain and straw yield (Table 4) of the crop Sharma and Yadav (1986) [8].

Effect of organic and inorganic amendments on nutrient content in paddy

The nitrogen content in both grain and straw increased significantly with dose of gypsum, $ZnSO_4$, FYM and Green manure along with RDF which might be attributed to the supply of nitrogen through chemical fertilizers and decomposition of FYM and Green manure results in mineralization of nitrogen and thereby increases the supply of nitrogen throughout the crop growth Hussain *et al*., 1997 [4] (Table 5).

Chhabra *et al.* (1981) [3] reported that the increase in P concentration might be attributed to the increasedorganic carbon content of soil due to decomposition of added FYM. During decomposition, various organic and inorganic acids were released which helps in solubilisation of fixed phosphorus. In addition to this, the plant roots also helped in the dissolution of inorganically bound P into soil available pool and therebyincreasing its absorption by the plant. The increase in potassium content in grain and straw of rice could be due to the ameliorating effect of gypsum Singh *et al*. (1980) [9] (Table 5).

Combine application of organic and inorganic amendments increases the calcium content in grain and straw of rice Patel and Singh (1997) [6]. The enhancement in magnesium content in grain and straw of rice due to the application of gypsum was also reported by Singh *et al*. (1980) [9]. The higher sulphur content in the Gypsum and also release of sulphur upon decomposition of FYM and green manure and also supply of $ZnSO_4$ might have resulted in increased sulphur concentration in grain and straw Prasad *et al*. (2010) (Table 6).

Anand Swarup (1991) indicated that application of gypsum alone or in combination with FYM or green manure along with zinc significantly increased the Zn, Cu, B, Fe and Mn concentration in rice crop. Addition of organic manures to soil besides increasing the availability of micronutrients in soil, the complexing properties of these manure with micronutrients might have prevent the precipitation, fixation, leaching and kept them in soluble form which might have resulted in higher concentration of these micronutrients by soybean crop (Table 7).

Effect of organic and inorganic amendments on nutrients uptake by paddy

The improvement in uptake of nutrients like N, P and K by grain and straw of rice with the combined application of gypsum and organic amendments might be due to the fact that reduced the exchangeable sodium percent of soil which in turn increased the availability of nutrients and there by higher nutrient uptake. Similar results were also reported by Prasad *et al*. (2010) [7] (Table 8).

Patel and Singh (1997) [6] reported that addition of amendments like gypsum and combination of gypsum and FYM brought about significant increase in calcium, magnesium by dissolution and sulphur by mineralization processes, resulted in increased uptake of calcium, magnesium and sulphur. The higher uptake of sulphur was also influenced by zinc sulphate application (Table 9).

The nutrients uptake further increased with increasing dose of NPK and addition of FYM. The increased uptake of micronutrients by FYM addition might be attributed to extra amount of nutrients supplied by the FYM, besides beneficial effect of organic matter addition on the availability of soil nutrients. The mineralization of applied organic matter released the nutrients contained in them, besides the acids that are released during the decomposition might have helped in solubilizing the unavailable forms of nutrients, thus increasing the availability of nutrients. (Charati and Malakouti, 2006) [2] (Table 10).

Table 1: Initial physical and chemical properties of the experimental site

Physical parameters	
Sand sized particles (%)	47.18
Silt sized particles (%)	15.33
Clay sized particles (%)	36.49
Texture	Sandy Clay
Bulk density (Mg m^{-3})	1.45
MWHC (%)	32.67
Chemical parameters	
pH (1:2.5 Soil water suspension)	8.2
Electrical conductivity (dS m^{-1}) (1:2.5)	1.1
Organic carbon (g kg^{-1})	3
Available Nitrogen (kg ha^{-1})	313.6
Available Phosphorus (kg ha^{-1})	211.42
Available Potassium (kg ha^{-1})	123.78
Exchangeable Calcium [cmol (p^+) kg^{-1}]	12.82
Exchangeable Magnesium [cmol (p^+) kg^{-1}]	3.89
Exchangeable Sodium (cmol (p^+) kg^{-1})	0.98
CEC (cmol (p^+) kg^{-1})	14.3
Available Sulphur (mg kg^{-1})	10.76
DTPA-Iron (mg kg^{-1})	0.51
DTPA- Manganese (mg kg^{-1})	9.99
DTPA- Copper (mg kg^{-1})	3.17
DTPA-Zinc (mg kg^{-1})	1.04
Boron (mg kg^{-1})	0.51
CO_3^{2-}(mg kg^{-1})	ND
HCO_3^-(mg kg^{-1})	531.7
Cl^-(mg kg^{-1})	810.1
ESP	6.1

Table 2: Effect of organic and inorganic amendments on plant height and number of tiller per hill of paddy of at different days after transplanting

Treatments	**Plant height (cm)**				**Number of tillers per hill**			
	30 DAT	**60 DAT**	**90 DAT**	**At harvest**	**30 DAT**	**60 DAT**	**90 DAT**	**At harvest**
T_1	33.13	62.93	80.22	82.95	10.80	14.27	15.27	16.27
T_2	32.73	64.73	81.43	83.87	11.93	14.33	15.63	16.87
T_3	33.53	64.40	81.47	83.77	11.80	14.30	15.73	16.73
T_4	31.47	64.27	82.33	84.13	12.20	14.07	15.80	17.32
T_5	34.53	63.27	81.67	83.60	12.80	14.54	16.57	17.20
T_6	32.13	65.07	82.89	84.47	12.00	13.93	15.77	17.33
T_7	32.83	64.33	82.56	84.20	11.33	14.47	15.32	17.13
T_8	36.53	66.67	84.56	86.67	13.33	15.70	15.90	17.87
T_9	35.93	66.47	84.99	86.47	13.07	15.60	15.87	17.80
S. Em±	0.21	0.08	0.14	0.10	0.08	0.03	0.21	0.02
C. D. at 5%	0.65	0.25	0.45	0.31	0.28	0.12	0.70	0.10

Table 3: Effect of organic and inorganic amendments on panicle length, test weight, number of grains $panicle^{-1}$ and number of unfilled grains $panicle^{-1}$ at different days after transplanting of paddy

Treatments	**Panicle length (cm)**	**Test weight (gm)**	**Number of grains $panicle^{-1}$**	**Number of unfilled grains $panicle^{-1}$**
T_1	21.06	17.13	307.60	67.07
T_2	21.40	17.30	333.53	77.47
T_3	21.19	17.14	330.17	84.53
T_4	21.25	17.33	347.40	91.20
T_5	21.26	17.27	331.67	94.57
T_6	21.45	17.37	350.07	100.33
T_7	21.31	17.30	344.07	100.80
T_8	21.51	17.63	363.87	127.40
T_9	21.48	17.40	359.20	122.80
S. Em±	0.15	0.06	7.70	11.72
C. D. at 5%	0.46	0.19	22.14	35.14

Table 4: Effect of organic and inorganic amendments on grain yield, straw yield and harvest index of paddy

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index
T_1	3953	4348	0.46
T_2	4949	5444	0.47
T_3	4550	5005	0.46
T_4	5206	5727	0.47
T_5	5084	5592	0.47
T_6	5014	5516	0.47
T_7	5023	5525	0.47
T_8	6266	6892	0.47
T_9	6238	6862	0.47
S. Em±	322.1	354.3	0.003
C. D. at 5%	965.7	1062.3	0.01

Table 5: Effect of organic and inorganic amendments on major nutrient content in paddy grain and straw

Treatments	N (%)		P (%)		K (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
T_1	1.04	1.27	0.21	0.11	0.21	0.75
T_2	1.15	1.28	0.49	0.23	0.27	0.84
T_3	1.30	1.27	0.34	0.34	0.33	0.83
T_4	1.06	1.45	0.39	0.38	0.26	0.84
T_5	1.05	1.45	0.41	0.39	0.27	0.82
T_6	1.09	1.41	0.47	0.41	0.28	0.83
T_7	1.15	1.39	0.58	0.43	0.32	0.83
T_8	1.41	1.72	0.63	0.55	0.39	0.84
T_9	1.21	1.45	0.61	0.51	0.36	0.83
S. Em±	0.05	0.09	0.01	0.01	0.011	0.012
C. D. at 5%	0.16	0.28	0.03	0.06	0.032	0.036

Table 6: Effect of organic and inorganic amendments on secondary nutrient content in paddy grain and straw

Treatments	Ca (%)		Mg (%)		S (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
T_1	0.11	0.15	0.02	0.05	0.11	0.10
T_2	0.11	0.16	0.03	0.07	0.15	0.13
T_3	0.12	0.20	0.03	0.05	0.16	0.15
T_4	0.12	0.20	0.04	0.05	0.14	0.11
T_5	0.12	0.16	0.04	0.08	0.14	0.13
T_6	0.12	0.16	0.03	0.07	0.15	0.17
T_7	0.11	0.16	0.02	0.08	0.14	0.16
T_8	0.15	0.22	0.05	0.08	0.19	0.19
T_9	0.13	0.20	0.04	0.08	0.18	0.17
S. Em±	0.007	0.007	0.05	0.005	0.006	0.001
C. D. at 5%	0.021	0.022	0.014	0.015	0.02	0.03

Table 7: Effect of organic and inorganic amendments on micronutrient content in paddy grain and straw

Treatments	Mn (mg kg^{-1})		Cu (mg kg^{-1})		Zn (mg kg^{-1})		Fe (mg kg^{-1})		B (mg kg^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	24.20	25.00	14.63	16.00	17.40	35.67	114.00	196.50	14.34	10.55
T_2	28.40	35.00	17.50	17.67	32.30	45.00	125.00	251.00	14.87	12.49
T_3	27.60	26.00	17.57	17.00	18.50	36.67	119.00	273.50	16.10	12.61
T_4	25.50	34.00	14.99	17.33	33.60	37.33	126.00	257.00	15.53	11.55
T_5	28.66	33.00	15.77	18.00	27.00	36.67	125.00	292.00	16.07	11.61
T_6	26.00	31.00	18.77	18.33	26.20	37.00	127.00	291.50	15.47	13.12
T_7	27.70	35.00	18.50	17.33	26.80	38.33	123.00	292.50	15.23	11.52
T_8	36.97	46.57	21.50	21.00	35.30	56.00	134.00	337.00	18.50	15.85
T_9	33.20	36.00	19.43	20.00	34.40	52.00	132.33	332.50	17.73	15.75
S. Em±	1.25	3.48	0.70	0.34	0.40	1.35	0.54	1.52	0.25	0.03
C. D. at 5%	3.88	10.57	2.12	1.02	1.20	4.12	1.67	4.56	0.80	0.12

Table 8: Effect of organic and inorganic amendments on major nutrients uptake by paddy grain and straw

Treatments	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
T_1	41.23	47.85	8.30	4.78	8.36	29.96
T_2	57.28	59.64	24.25	12.52	13.71	41.83
T_3	59.48	55.05	15.47	17.01	15.10	38.18
T_4	55.27	68.41	20.30	21.76	13.84	44.13
T_5	53.69	76.06	20.84	21.81	14.07	41.95
T_6	55.38	80.27	23.57	22.61	14.19	42.00
T_7	57.89	66.99	29.14	23.76	16.27	39.92
T_8	77.95	82.10	39.47	35.15	21.95	48.51
T_9	67.99	83.61	38.07	37.74	20.31	46.84
S. Em±	3.85	0.50	0.55	1.02	0.53	0.54
C. D. at 5%	11.08	1.51	1.67	3.12	1.66	1.69

Table 9: Effect of organic and inorganic amendments on secondary nutrients uptake by paddy grain and straw

Treatments	Ca (kg ha^{-1})		Mg (kg ha^{-1})		S (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
T_1	4.46	7.76	1.12	2.26	4.52	5.58
T_2	5.78	8.70	1.82	4.14	7.80	6.89
T_3	5.45	9.08	1.36	3.28	7.51	7.13
T_4	6.61	9.06	2.11	2.58	7.43	6.95
T_5	6.43	8.13	2.03	4.07	7.34	6.96
T_6	6.34	8.22	1.30	3.96	7.78	8.74
T_7	5.97	8.09	1.44	3.95	7.32	5.83
T_8	8.67	12.41	2.95	4.84	10.84	10.83
T_9	7.27	11.41	2.39	4.18	10.75	9.25
S. Em±	0.53	0.67	0.21	0.38	0.46	0.59
C. D. at 5%	1.54	2.03	0.60	0.67	1.33	1.78

Table 10: Effect of organic and inorganic amendments on micronutrients uptake by paddy grain and straw

Treatments	Fe(g ha^{-1})		Mn (g ha^{-1})		Cu(gha^{-1})		Zn (g ha^{-1})		B (g ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	450.68	854.50	95.67	108.72	57.84	69.58	68.79	155.11	56.69	45.88
T_2	618.67	1366.49	140.56	190.55	86.61	96.20	159.86	244.99	73.60	68.00
T_3	541.45	1368.92	125.58	130.13	79.94	85.09	84.18	183.54	73.26	63.12
T_4	656.04	1471.92	132.77	194.73	78.05	99.25	174.94	213.80	80.86	66.15
T_5	635.50	1632.98	145.70	184.55	80.17	100.66	137.27	205.07	81.70	64.93
T_6	636.86	1607.94	130.38	171.00	94.13	101.11	131.38	204.10	77.58	72.37
T_7	617.87	1616.24	139.14	198.92	92.93	95.76	134.63	211.80	76.51	63.65
T_8	835.98	2322.81	231.65	320.99	134.72	144.74	220.22	385.99	115.42	109.25
T_9	829.18	2281.78	207.12	240.19	121.22	137.25	215.55	356.85	111.10	108.08
S. Em±	2.31	13.67	8.26	27.34	4.52	2.49	1.55	9.71	1.44	0.38
C. D. at 5%	7.00	42.51	25.35	81.23	13.65	7.55	4.72	29.56	4.52	1.17

Conclusion

The treatment imposed of 100% NPK + Green manure + $ZnSO_4$ + Gypsum + FYM significantly improved the growth, yield of rice and nutrient content and uptake by rice crop compared to 100% NPK + FYM (POP).

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