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Nutrient Management in Wheat (*Triticum aestivum* L.) under Partially Reclaimed Coastal Salt Affected Soil of South Gujarat

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A B S T R A C T

An experiment was conducted at Coastal soil salinity research station, Navsari Agricultural University, Danti during rabi seasons of 2016-17 and 2017-18 to study the effect of different levels of fertilizer on yield and nutrient uptake of wheat under partially reclaimed coastal salt affected soil of South Gujarat. The pooled results revealed that organic manures and fertilizer levels treatments influenced significantly the plant population at harvest, yield attributes, yield and economics of wheat crop. Application of FYM @ 10 t ha-1and higher dose of fertilizer i.e.120% RDF (216-108-00 kg NPK ha^{-1}) treatment recorded significantly higher values of the growth parameters like plant height at 60 DAS (47.2 and 47.3cm), at harvest (87.3 and 87.4 cm), total tillers m^{-1} (110.3 and 110.9 cm), yield attributes like effective tillers (105.2 and 106.2 cm), spike length (8.5 and 8.8 cm) , spikelets $spike^{-1}$ (12.8 and 13.4) grains $spike^{-1}$ (29.2 and 29.1) etc., grain yield (3931 and 3896 kg ha^{-1}) and straw yield (5246 and 5323 kg ha^{-1}) of wheat crop. The net returns ha^{-1} (Rs. 51569 and Rs. 51468) and BCR (2.28 and 2.29) were maximum under FYM @ 10 t ha^{-1} and 120% RDF treatments, respectively.

Introduction

Wheat is world's leading cereal crop, cultivated near about 290.10 million hectares with a production of 730 million tonnes of grain with 2717 kg ha^{-1} productivity (2016-17). India (30.06 million ha) ranks first in area coverage followed by China (24.13 million ha), while in production China stands first (134.34 million tonnes) and India ranks second (98.51 million tonnes). Wheat (*Triticum spp*.) is the second most important winter cereal in India after rice. The share of Wheat in total food grain production is around 36.25% and share in area is about 24.83 % of the total area under food grains. About 99.5% of the wheat production comes from Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Maharashtra, Gujarat, Karnataka, West Bengal. Wheat is the one of the staple foods of north Indian population. Wheat grains are ground into flour (atta) and consumed mostly in the form of chapati or leavened bread. Soft wheat is used for making

chapati, bread, cake, biscuits, pastry and other bakery products whereas hard wheat is used for manufacturing rawa, suji, and sewaya. In areas where rice is a staple food grain, wheat is also eaten in the form of puri etc. It is also used for making cakes and sweet meats etc. Wheat grain is used for preparing starch. Wheat straw is used as fodder, padding material and mulching material. The productivity of a crop is controlled by many factors of which the mineral nutrition especially of nitrogen is by and large. The most important factor is that the heavy and imbalanced use of chemical fertilizer has led to think about the use of organic manures in intensively growing areas for sustainable production system. The nutrient management is one of the paramount in crop production. The recent concept of integrated use of various sources of nutrient in crop production has started gaining ground. The basic concept underlying the principle of integrated nutrient supply system is to improve of soil fertility for sustainable crop production on long term basis. The inclusion of organic manures regulates nutrients uptake, improves crop yields and physical and chemical properties of soil and produces a synergistic effect (Yadav and Kumar, 2000). The combined use of organic and inorganic sources of nitrogen increases the production and profitability of field crops and helps in maintaining the fertility status of the soil. The integrated nutrient management has been found to be quite promising not only in increasing the productivity, but also greater stability in crop production (Nambiar and Abrol, 1992).

Therefore, to sustain the land and to achieve production potential of crops, judicious use of inorganic fertilizer with organic manures and their scientific management is important. It must be stressed that the value of FYM, vermicompost, poultry manure and green leaf manure in soil improvement is due to there nutrient content, besides helping in the improvement of soil structure and water holding capacity of soil (Kale and Bano, 1986). In view of this the present investigation was carried out to know the effect of organic manures on seed yield and quality of wheat. However, very less information was reported on the nutrient management in wheat crop under salt affected area in South Gujarat. Keeping with these points, the study be carried out on land configuration with integrated nutrient management in wheat (*Triticum aestivum* L.) under partially reclaimed coastal salt affected soil

Materials and Methods

The experiment were carried out at Coastal soil salinity research station, Navsari Agricultural University, Danti which is located about one km away from the Arabian Sea towards East and geographically at 20^{o} 83‟N latitude and 72^{o}52‟E longitude with altitude of 2.5 m above mean sea level. The soil is classified as “Calcareous soil” characterized by very high clay content, with good moisture holding capacity and low to very low permeability. The soils develop deep cracks and become extremely hard when dry, while plastic and sticky when wet. The average thickness of solum ranged from 2.5 to 3.0 m (Table 1).

The rooting depth is extended up to 1.0 m. The soil of the experimental field was clayeyin texture, bulk density (1.65 gcc^{-1}) slightly alkaline in pH (8.38 to 8.35), medium in salinity $EC_{2.5}$ (2.01 to 2.04 dS m^{-1}), low in OC (0.42 to 0.43 6%) CEC (40.70 to 44.05 [cmol (p^{+}) kg^{-1}] and ESP (12.25 to 12.77 [cmol (p^{+}) kg^{-1}] partially saline-sodic and showed medium, medium and high rating of low available nitrogen (266 to 271 kg ha^{-1}), medium in available phosphorus (39.15 to 40.35 kg ha^{-1}) and high in available potassium (615 to 645 kg ha^{-1}) in surface soil.

The experiment was laid out in split plot design with four replications. The experiment comprising of twenty-seven treatment combinations consisting of three level of land configuration factor taken in main plot which are L_1: Flat bed, L_2: Broad bed furrow and L_3: ridge and furrow, while organic manures and fertilizer levels are taken in sub-plot treatment which are O_1: Control (without organic manure), O_2: FYM @ 10 t ha^{-1} and O_3:Bio-compost @ 10 t ha^{-1} as organic manure treatments and fertilizer level treatments were F_1:80% RDF (144-72-00 kg NPK ha^{-1}), F_2:100% RDF (180-90-00 kg NPK ha^{-1}) and F_3:120% RDF (216-108-00 kg NPK ha^{-1}).

Treatments were allotted randomly within each replication. FYM and bio-compost were applied in respective treatments after preparing beds mix with soil by using *kudali* and then ridge and furrow and raised beds were prepared. FYM and Bio-compost @ 10 t ha^{-1} each were applied in respective treatments before sowing of crop. The basal dose of phosphorus was given with entire quantity and nitrogen was given in split doses *i.e.* 40% at time of sowing, 40% at 30 DAS and 20% at spike initiation stage (60 DAS) in the form of urea and phosphorus in the form of single super phosphate were applied as per the treatments in each plot.

Results and Discussion

The different organic manures and levels of fertilizer treatments remarkably influenced the plant population, growth parameters yield attributes and yield of wheat crop.

The application of FYM @ 10 t ha^{-1} treatment recorded significantly higher plant stand (18.50 lakh ha^{-1}) than without organic manures treatment, but it remained at par with bio-compost @ 10 t ha^{-1} treatment at harvest. The application of organic manures either FYM or bio-compost improved the germination of crop and plant establishment during the present investigation conducted in salt affected soils of coastal area. The application of 120% RDF treatment (216-108-00 kg NPK ha^{-1}) recorded significantly higher plant count (18.46 lakh ha^{-1}) and it was statistically at par with 100 % RDF treatment (180-90-00 kg NPK ha^{-1}) on pooled basis at harvest.

Higher plant stand might be attributed to addition of organic matter *i.e.*, FYM and bio-compost, increase aeration and conducive air-water relationship, further improves physical condition of soil and increased the availability of nutrients and favorable condition for germination, establishment as well as growth and development of plants. These results are akin with finding of Vaithiyanathan and Sundaramoorthy (2016).

Growth parameter

Plant height (cm)

The plant height at 60 DAS and harvest were significantly influenced due to different organic manures and levels of fertilizer treatment on pooled basis. The application of FYM @ 10 t ha^{-1}recorded significantly higher plant height which were 47.2 and 87.3 cm but it remained statistically at par with treatment of bio-compost @10 t ha^{-1} at 60 DAS and harvest, respectively.

The increased in plant height attributed to the nutritive effect of FYM. In case of fertilizer levels, on pooled basis results, the plant height were significantly higher in the treatment of 120% RDF treatment which were 47.3 and 87.4 cm at 60 DAS and harvest, respectively. The increased in plant height attributed to the nutritive effect of FYM conformity with those of Abro and Mahar (2007), Haq *et al.*, (2007) and Haque *et al.*, (2015) in rice crop.

Total tillers m^{-1} row length

The total tillers m^{-1} row length at 60 DAS was significantly affected due to organic manures and fertilizer doses treatments. Application of FYM @ 10 t ha^{-1} registered significantly superior and produced the highest number of tillers (110.3) than rest of the treatments on pooled basis. The less number of tillers m^{-1} (106) noted in without organic manure treatment. This might be due to addition of FYM in conjunction with all necessary major and micro nutrients and their uptake by the wheat crop and as a result higher dry matter accumulation and their translocation in plant parts favored the growth and ultimately increased yield parameters. These findings are in support of previous findings of Ibrahim *et al.,* (2008), Jaga and Upadhay (2013) and Kakraliya *et al.,* (2017). The fertilizer treatment F_3 (216-108-00 kg NPK ha^{-1}) registered significantly the highest number of tillers (110.9) in pooled results. The lowest number of tillers (105.2) observed in treatment of 80% RDF. This might be due to vigorous growth of plants with higher levels of major nutrients in terms of plant height and dry matter production, which resulted in adequate food supply to sink and ultimately reflected on better growth attributes. Similar results have been also reported bySingh *et al.,* (2007), Jat *et al.,* (2013) and Rahman *et al.,* (2014).

Yield attributes

Effective tillers m^{-1} at harvest

The FYM @ 10 t ha^{-1} treatment registered significantly higher number of effective tillers (105.2), but it remained at par with treatment of bio-compost @ 10 t ha^{-1}. The application of 120% RDF treatment noted significantly superior in effective tillers m^{-1} row length (106.2) in pooled analysis over remaining levels of fertilizer. The lowest effective tillers were 100.2 and 99.45 observed in the control (without manure) and 80% RDF treatment, respectively. The results also get support from the findings of Kiani *et al.,* (2005), Usadadiya and Patel (2013), Rahman *et al.,* (2014) and Bashir *et al.,* (2015).

Spike length (cm) at harvest

The FYM @ 10 t ha^{-1} treatment (O_2) recorded significantly higher spike length (8.5 cm), but it remained statistically at par with treatment O_3 (Bio-compost @ 10 t ha^{-1}). In case of fertilizer levels, application higher dose of fertilizer i.e. 120% RDF (216-108-00 kg NPK ha^{-1}) recorded significantly highest (8.8 cm) spike length than rest of fertilizer levels.

This might be due to better growth of plants with higher levels of major nutrients in terms of plant height and dry matter production, which resulted in adequate food supply to sink and ultimately reflected into better yield attributes. These results are in agreement with the finding of Singh *et al.,* (2007) and Kashyap *et al.,* (2017). The minimum spike length was observed in control (without organic manure) and 80% RDF (144-72-00 kg NPK ha^{-1}) treatment.

Number of spikelets $spike^{-1}$

The number of spikelets $spike^{-1}$ significantly influenced due to different organic manures and levels of fertilizer at harvest in combined analysis. The FYM @ 10 t ha^{-1} and 120% RDF treatment recorded significantly the highest number of spikelets $spike^{-1}$were 12.8 and 13.4, respectively than remaining treatments. This might be due to addition of organic manure improve air-water relationship, further improves physical condition of soil and also soil fertility. Similar findings were also reported by Ibrahim *et al.,* (2008) and Patel (2017).

Number of grains spike^{-1}

Application of FYM @ 10 t ha^{-1} and 120% RDF treatments were produced significantly the highest number of grains spike^{-1}29.2 and 29.1, respectively. The lowest values are observed in control and 80% RDF treatments. This might be due to adequate quantities of plant nutrients supplied to the crop as per need during the growth period. This is in agreement with the earlier findings of Usadadiya and Patel (2013), Rahman *et al.,* (2014), Mandik *et al.,* (2015) and Mohan *et al.,* (2018).

Yield and harvest index

On pooled basis, the treatments O_2 (FYM @ 10 t ha^{-1}) produced significantly the highest grain (3931 kg ha^{-1}) and straw yield (5776 kg ha^{-1}) than rest of treatments. The lowest grain and straw yields were observed under control (without organic manure) treatment. This could be due to higher availability of nutrients and modifying soil environment for better retention of nutrients and water during critical growth stages of crop due to addition of organic manures and ultimately increases the yield attributes and directly effect on grain yield of wheat.

These findings corroborate the results obtained byRegar *et al.,* (2005), Singh *et al.,* (2007), Sarvar *et al.,* (2008) and Shah *et al.,* (2010) due to application of organic manures. The application of 120% RDF (216-108-00 kg NPK ha^{-1}) treatment registered significantly the highest grain (3896 kg ha^{-1}) and straw yield (5323 kg ha^{-1}) than rest of fertilizer levels. The lowest grain and straw yield were recorded in 80% RDF treatment.

The treatment O_2(FYM @) 10 t ha^{-1}) and 120% RDF registered significantly higher harvest index were 42.65 and 42.23%,but at par with Bio-compost @10 t ha^{-1} and 100% RDF treatments, respectively. The lowest harvest index was 40.66 and 41.50% observed under control (without manures) and 80% RDF, respectively. This might be due to higher growth and yield attributes, photosynthetic activity leading to higher dry matter accumulation, which may directly influence the grain and straw yields as well as harvest index. The present findings are in concurrence with the findings of Jat *et al.,* (2013), Meena *et al.,* (2013) and Kashyap *et al.,* (2017) (Table 2 and 3).

Table.1 Initial soil properties of experimental site

Sr. No	Particular	Values	Analytical method applied
1.	Texture	Clayey	
2.	$pH_{1:2.5}$	8.35 - 8.38	Potentiometric
3.	$EC_{1:2.5}$(dSm^{-1})	2.01 - 2.04	Conductometric
4.	Organic Carbon (%)	0.42 - 0.43	Walkley and Black's rapid titration method
5.	CEC [cmol(p+)kg^{-1}]	40.70 - 40	Flame photometric method
6.	ESP (%)	12.25 - 12.77	
7.	Available nitrogen (kg ha^{-1})	266 - 271	Alkaline KMnO4 method
8.	Available phosphorus (kg ha^{-1})	39.15 - 40.35	Olsen's, method
9.	Available potassium (kg ha^{-1})	615-645	Flame photometric method

Table.2 Effect of organic manures and fertilizer levels on growth parameters and yield attributes of wheat crop on two years pooled basis

Treatments	Plant population at harvest	Plant height (cm)		Total tillers m^{-1} at 60 DAS	Effective tillers m^{-1} at harvest	Spike length (cm) at harvest	Spikelets $spike^{-1}$ at harvest	Grains $spike^{-1}$ at harvest
		At 60 DAS	At harvest					
A. Organic manures								
O_1 – Control (without manures)	18.23	46.4	85.3	106.0	100.2	8.3	11.4	27.2
O_2 – FYM @ 10 t ha^{-1}	18.50	47.2	87.3	110.3	105.2	8.5	12.8	29.2
O_3 – Bio-compost @ 10 t ha^{-1}	18.36	46.9	86.7	108.6	103.8	8.4	12.3	28.3
S.Em.±	0.07	0.19	0.37	0.53	0.50	0.03	0.09	0.11
CD (P=0.05)	0.22	0.54	1.03	1.49	1.40	0.09	0.27	0.33
B. Fertilizer levels								
F_1 – 80% RDF (144-72-00 kg NPK ha^{-1})	18.20	46.2	85.3	105.2	99.40	8.0	10.8	27.0
F_2 – 100% RDF (180-90-00 kg NPK ha^{-1})	18.42	47.0	86.5	108.8	103.60	8.6	12.4	28.6
F_3 – 120% RDF (216-108-00 kg NPK ha^{-1})	18.40	47.3	87.4	110.9	106.2	8.8	13.4	29.1
S.Em.±	0.07	0.19	0.37	0.53	0.50	0.03	0.09	0.11
CD (P=0.05)	0.22	0.54	1.03	1.49	1.40	0.09	0.27	0.33
C.V.%	3.60	3.55	3.64	4.22	4.14	3.53	6.74	3.66

Table.3 Effect of organic manures and fertilizer levels on yields, nutrient uptake, protein content and economics of wheat crop

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Nutrient uptake (kg ha^{-1})			Harvest index (%)	Protein content (%)	Net returns (Rs.)	BCR
			N	P	K				
A. Organic manures									
O_1 – Control (without manures)	3362	4897	89.85	12.41	129.33	40.66	11.03	11.40	2.26
O_2 – FYM @ 10 t ha^{-1}	3931	5246	104.39	15.09	143.41	42.65	11.35	12.8	2.28
O_3 – Bio-compost @ 10 t ha^{-1}	3820	5184	100.77	14.28	141.32	42.25	11.17	12.3	2.22
S.Em.±	16.57	35.54	0.63	0.09	1.23	0.20	0.06	0.27	-
CD (P=0.05)	46.32	99.36	1.78	0.26	3.43	0.57	0.17	6.74	-
B. Fertilizer levels									
F_1 – 80% RDF (144-72-00 kg NPK ha^{-1})	3517	4925	90.59	12.21	132.84	41.50	10.88	10.8	2.22
F_2 – 100% RDF (180-90-00 kg NPK ha^{-1})	3701	5078	98.85	14.07	139.06	41.97	11.27	12.4	2.25
F_3 – 120% RDF (216-108-00 kg NPK ha^{-1})	3896	5323	105.76	15.50	142.15	42.09	11.40	13.4	2.29
S.Em.±	16.57	35.54	0.63	0.09	1.23	0.20	0.06	0.09	-
CD (P=0.05)	46.32	99.36	1.78	0.26	3.43	NS	0.17	0.27	-
C.V.%	3.79	5.90	5.07	5.78	7.56	4.19	4.86	6.74	-

Protein content (%)

On pooled basis, there was no any significant effect on protein content in wheat grain due to application of organic manures, while fertilizer levels remarkably affect the protein content in grain, 120% RDF treatment noted significantly higher protein content (11.40%) but it was statistically at par with 100% RDF treatment. The improvement in protein content in grain was owing to increase in N content in grain due to enhanced availability of this nutrient and improved soil environment with fertilizer application. Jat *et al.,* (2013) and Ullah *et al.,* (2013) in wheat also reported the significant response of nutrient management in protein content.

Nutrient uptake

On pooled basis, the FYM @ 10 t ha^{-1} and 120% RDF (216-108-00 kg ha^{-1}) treatments recorded significantly the highest total nitrogen (104.39 and 105.76kg ha^{-1}), phosphorus (15.09 and 15.50 kg ha^{-1}) and higher potassium uptake (143.41 and 142.13 kg ha^{-1}). This might be due to higher crop biomass production and better nourishment resulted into higher uptake of plant nutrients. Similar results were also reported by Murtaza *et al.,* (2000) and Jat *et al.,* (2013). The lowest nutrient uptake were obtained in treatment O_1 (control) and

Economics

The maximum net returns of ₹.51569 ha^{-1} and B:C ratio of 2.28 were incurred under the treatment of FYM @ 10 t ha^{-1} followed by bio-compost @ 10 t ha^{-1} treatment. The minimum net realization of ₹.44329 ha^{-1} with B:C ratio of 2.26 were noted under without organic manure treatment. The application of 120% RDF treatment secured maximum net returns ₹.51468 $ha^{-1}$with BCR of 2.29. The increase in net returns and B:C ratio due to increase in fertilizer levels which produced higher yields of wheat. Similar results were reported by Sarwar *et al.,* (2008), Gupta *et al.,* (2011) and Kumar *et al.,* (2018).

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