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Residual effect of organic and inorganic amendments on nutrient uptake by *rabi* onion under coastal soil

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Abstract
A field experiment was carried out at the Coastal Soil Salinity Research Station, NAU, Danti, Gujarat, duuring 2020–21 and 2021–22 to study the residual effect of organic and inorganic amendments on nutrient uptake by *rabi* onion under coastal soils. The field experiment consisted of different treatments *viz*., T_1: Control (Without biocompost (BC) and gypsum), T_2: Biocompost @ 10 t/ha, T_3: Gypsum @ 50% GR, T_4: Gypsum @ 50% GR + biocompost @ 10 t/ha, T_5: Gypsum @ 75% GR, T_6: Gypsum @ 75% GR + biocompost @ 10 t/ha, T_7: Gypsum incubated biocompost @ 50% GR (BC @10t/ha) and T_8: Gypsum incubated biocompost @ 75% GR (BC @10t/ha) were applied to proceeding *kharif* rice crop and their residual effect was studied on *rabi* onion. The study's findings showed that the total nutrient uptake (bulb and leaves) by *rabi* onion were recorded significantly higher with residual effect of gypsum incubated biocompost @ 75% GR (T_8) followed by gypsum incubated biocompost @ 50% GR (T_7) during both of the years of study and combined outcomes.

Keywords: Amendments, onion, nutrient uptake, coastal soil

Introduction
A biennial or perennial herb, onion (*Allium cepa* L.) is a member of the Amaryllidaceae family. Among bulb crops, it is one of the most importance cash vegetable crops and is semi-perishable. The significance of crop further enhances due to its multiple uses. Because of its highly valued flavor, aroma and unique taste as well as the medicinal qualities of its flavor compounds, it is frequently referred to as the "Queen of the Kitchen." Since ancient times, onions have been esteemed as food and medicinal plants. It is a vegetable bulb crop that is grown extensively second only to tomatoes in terms of cultivation and is consumed all over the world. India comes in second place in terms of area but third place in terms of production when it comes to global onion production (Anon., 2020a) [1]. Canada, Japan, Spain, the Netherlands, and North America are among the major producers of onions. Yet, Gujarat, Maharashtra, and Madhya Pradesh are the Indian states where it is grown. Gujarat grows onions on over 0.2249 lakh hectares of land and produces 0.5462 metric tonnes of onions annually (Anon., 2020b) [2].

The soil of coastal areas of South Gujarat is saline and saline sodic in nature with poor physical condition, thereby adversely effects on the productivity of crops. Salt toxicity and poor soil qualities are two of the main causes of decreased crop productivity on Coastal soil. Thus, there is a need for effective, low-cost treatment methods to enhance the characteristics of soil and lessen its toxicity to salt. With both organic and inorganic amendments, improving crop productivity on salt-affected soils is becoming a more important technique. Many research have been conducted to determine which amendments are most successful at enhancing the chemical and physical characteristics of salt-affected soils. Among these amendments, in order to recover the physico-chemical properties of salt-affected soil, biocompost, an industrial byproduct, is widely available and can hasten the solubilization of gypsum through organic acids formed during organic matter decomposition (Ramaswamy, 1999; Kumar and Verma, 2002; Nehra and Hooda, 2002; Rangaraj *et al*., 2007; Jamil *et al*., 2008; Muhammad and Khattak, 2009) [8, 5, 7, 9, 4, 6]. Furthermore, biocompost enhance the supply of primary, secondary and micronutrients for proper growth and development of the plants and increase activity of soil microbes through providing energy.

It acts as thermo regulation in soil, improves buffering and exchange capacities of soil. It also improves the nutrient uptake by crop. Considering the above facts in view, the investigation was undertaken with the objective to study the residual effect of organic and inorganic amendments on nutrient uptake by *rabi* onion under coastal soils of south Gujarat.

Materials and Methods

The field experiment was carried out from 2020-21 to 2021-22 during the *rabi* season at the Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat in South Gujarat, India. Geographically, Danti-Umbharat is located on India's western coastal belt at 21° 01′ N latitude and 72° 74′ E longitude, with a height of 2.5 m above mean sea level. Rainfall in the area averages 1200 mm per year. The average minimum and maximum temperatures range from 12.1 to 26.5 °C and 21.8 to 34.6 °C, respectively. The soil in the experiment plot was clayey in texture; with pH values between 8.67 and 8.61, ECe values between 6.39 and 5.93 dS m^{-1}, and organic carbon values between 0.50 and 0.52%. The soil also had low available N levels (233 and 246 kg ha^{-1}), medium available P_2O_5 levels (45.8 and 43.3 kg ha^{-1}), and high available K_2O levels (1106 and 1023 kg ha^{-1}) in 2020 and 2021, respectively. The test variety of onion was Nasik red.

The field experiment consisted of different treatments *viz*., T_1: Control (Without biocompost (BC) and Gypsum), T_2: Biocompost @ 10 t/ha, T_3: Gypsum @ 50% GR, T_4: Gypsum @ 50% GR + BC @ 10 t/ha, T_5: Gypsum @ 75% GR, T_6: Gypsum @ 75% GR + BC @ 10 t/ha, T_7: Gypsum incubated biocompost @ 50% GR (BC @10t/ha) and T_8: Gypsum incubated biocompost @ 75% GR (BC @10t/ha) were applied to proceeding *kharif* rice crop and their residual effect was studied on *rabi* onion. There were three replications and a randomized block design used to set up the experiment. Gypsum, biocompost and gypsum incubated biocompost were applied to proceeding *kharif* rice crop as per treatments and evenly spread and mixed in that particular bed during land preparation. After harvest of proceeding *kharif* rice, *rabi* onion was transplanted. A 35-day-old, healthy onion seedling was wet transplanted onto flat beds with a 15 x 10 cm spacing. To facilitate good establishing, one-third of the seedling top was cut off at the time of transplanting. To lower the incidence of fungal infections during establishment, the onion seedling was transplanted after its roots were soaked in a 0.1% carbendazim solution for two hours. The recommended amount of fertilizer (80:40:00 NPK kg/ha) was applied to the onion crop. Before transplanting, half of the nitrogen and the entire amount of phosphorus were mixed in the particular beds. Two equal split doses of the remaining half-dosage of nitrogen were given as top dressing; the first dose was applied 30-35 days after transplanting, and the second dose was applied 45-50 days later. Onion crop was irrigated as per requirement.

To estimate the N, P, and K content, representative samples of the onion crop (leaves and bulbs) were obtained separately from each plot. After being dried in an oven at ± 65 °C for 24 hours, the samples were ground into a powder using a mechanical grinder and their nutrient content was determined using standard procedures listed below.

Particular	Procedure used	Reference
Nitrogen (%)	Micro kjeldahl's method (diacid)	Warnke and Barber (1974) [11]
Phosphorus (%)	Vanadomolybdo phosphoric acid yellow colour method	Jackson (1967) [3]
Potassium (%)	Flame photometric method	Jackson(1967) [3]

The following formula was used to determine how much N, P, and K were taken by crops:

$$\text{Nutrient uptake}\left(\frac{\text{kg}}{\text{ha}}\right) = \frac{\text{Nutrient content (\%)}}{100} \times \text{Yield (kg/ha)}$$

Total uptake of respective nutrient was worked out by summation of uptake by bulb and leaves of onion. Additionally, the total uptake of nutrients was emphasized more in this study.

Results and Discussion

Effect on Nutrient Uptake

The results (Table 1) showed that the nitrogen, phosphorous, and potassium uptake by the onion (bulb and leaves) crop during first and second years and in the pooled study was significantly affected by the residual effect of both organic and inorganic amendments.

The data of total nitrogen uptake of onion (bulb + leaves) (Table 1) showed significant differences among various treatments. Significantly maximum total nitrogen uptake of onion (bulb + leaves) was recorded 50.40, 53.97 and 52.19 kg/ha with application of gypsum incubated BC @ 75% GR (T_8) to preceding *Kharif* rice in the year 2020-21, 2021-22 and pooled result, respectively, which was at par with application of gypsum incubated BC @ 50% GR (T_7) during the year 2020-21, 2021-22 as well as in pooled results. Also at par with application of gypsum @ 75% GR + BC @ 10 t/ha (T_6) during the year 2021-22. The lowest content of total nitrogen uptake 34.41 kg/ha and 37.05 kg/ha recorded in control treatment (T_1) without BC and gypsum during both the years as well as 35.73 kg/ha in pooled analysis.

The data of total phosphorus uptake of onion (bulb + leaves) (Table 1) showed significant differences among various treatments. Significantly maximum total phosphorus uptake of onion (bulb + leaves) was recorded 14.46, 15.68 and 15.07 kg/ha with application of gypsum incubated BC @ 75% GR (T_8) to preceding *Kharif* rice in the year 2020-21 and 2021-22 and in pooled results, respectively which was comparable to application of gypsum incubated BC @ 50% GR (T_7) during the year 2021-22. The minimum content of phosphorus uptake recorded 8.73, 9.60 and 9.17 kg/ha with control (T_1) without BC and gypsum during 2020-21, 2021-22 and pooled result.

The data of total potassium uptake of onion (bulb + leaves) (Table 1) showed significant differences among various treatments. Significantly maximum total potassium uptake of onion (bulb + leaves) was recorded 48.28, 51.45 and 49.86 kg/ha with application of gypsum incubated BC @ 75% GR (T_8) to preceding *Kharif* rice in the year 2020-21, 2021-22 and pooled result, respectively which was at par application of gypsum incubated BC @ 50% GR (T_7) during both the years and application of gypsum @ 75%

GR + BC @ 10 t/ha (T_6) during 2021-22 year. The lowest content of total potassium uptake 31.49 kg/ha and 34.71 kg/ha in control (T_1) without BC and gypsum during 2020-21 and 2021-22 as well as 33.10 kg/ha in pooled analysis.

The residual effect of combined gypsum and biocompost enhanced soil physical conditions, which helped to reduce leaching losses, prolong nutrient availability, and synchronize nutrient release with crop demand, may account for the greater NPK uptake of onion bulbs and leaves. Similar results were observed by Rao and shaktawat (2000) [12], Ram *et al*. (2017) [13] and Singh *et al*. (2018) [10].

Table 1: Residual effect of organic and inorganic amendments on nutrient uptake by onion (bulb + leaves) at harvest

Treatments	Nitrogen uptake (kg/ha)			Phosphorus uptake (kg/ha)			Potassium uptake (kg/ha)		
	20-21	21-22	Pooled	20-21	21-22	Pooled	20-21	21-22	Pooled
T_1: Control (Without biocompost and gypsum)	34.41	37.05	35.73	8.73	9.60	9.17	31.49	34.71	33.10
T_2: Biocompost @ 10 t/ha	36.47	38.83	37.65	9.42	10.25	9.84	33.65	36.50	35.08
T_3: Gypsum @ 50% GR	38.59	41.50	40.04	10.16	11.13	10.64	35.88	39.13	37.50
T_4: Gypsum @ 50% GR + Biocompost @ 10 t/ha	41.68	44.83	43.26	11.24	12.32	11.78	39.18	42.39	40.78
T_5: Gypsum @ 75% GR	39.76	43.18	41.47	10.74	11.74	11.24	37.51	40.71	39.11
T_6: Gypsum @ 75% GR + Biocompost @ 10 t/ha	44.56	47.58	46.07	12.24	13.32	12.78	42.02	44.95	43.49
T_7: Gypsum incubated biocompost @ 50% GR	46.45	49.25	47.85	12.90	13.94	13.42	43.83	46.75	45.29
T_8: Gypsum incubated biocompost @ 75% GR	50.40	53.97	52.19	14.46	15.68	15.07	48.28	51.45	49.86
SEm±	1.86	2.39	1.60	0.47	0.64	0.42	1.66	2.34	1.51
CD at 5%	5.65	7.26	4.64	1.43	1.95	1.22	5.04	7.10	4.38
CV (%)	7.77	9.31	9.12	7.25	9.07	8.81	7.39	9.64	9.14
S.Em± (Y X T)	2.27			0.60			2.14		
CD at 5% (Y X T)	NS			NS			NS		

Conclusions

It was concluded that the nutrient uptake by onion (bulb and leaves) was higher with the residual effect of gypsum incubated biocompost @ 75% GR followed by gypsum incubated biocompost @ 50% GR in costal soils of south Gujarat.

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