Enhancement in fertility of saline soils of Gujarat using organic wastes

[1]Gayatri Gadhavi
Assistant Professor
Department of Life Sciences
HNG University Patan (Gujarat)

[2]Hitesh Solanki
Professor, Department of Botany, Bioinformatics & Climate Change Impacts Management,
(DST - FIST Department)
Head / Coordinator, Department of Environmental Science,
University School of Sciences,
Gujarat University

***Abstract*: Organic waste is the result of plants and animal decay. Organic waste plays an important role in improving and maintaining soil fertility. The chemical fertilizers increase the production but causes adverse impact to the soil specifically the soils under the stress of salts. Today the most important thing is better health and therefore food security plays a major role. The present study has shown change in the physiological function which led growth and fertility enhancement by different organic wastes in different crops. The use of such wastes can give sustainable productivity rise to the agriculture which has great positive effect on ecosystem as whole. Though all kinds of waste materials used in studies are helping to improve crop quality such leaf waste, Dung organic waste and agriculture Waste. The mixture of Agricultural waste + dung organic Waste worked most effectively into soil to enhance Biomass and productivity of crops.**

***Keywords*: Physiological function, Agriculture, crop Quality, Biomass and Productivity.**

Introduction

Use of chemical fertilizers is harmful at long turns in our life. Organic waste improves the crop nutrition and is helpful for better health (UNFCCC 2015). Organic nutrients play a major role in plant physiological function. It is also helpful to Soil in increasing water holding capacity, soil characteristics, nutrient accessibility (Oades, 1988; Johnsen et al., 2009). Organic products are of more price, and they are lesser available in market especially in south Asian countries. Organic fertilizer offers more micronutrient. (Haering *et al*., 2001). Mineral fertilizers affect ground water system, atmosphere through various ways leaching, run off (Yan *et al*., 2007).

Soil degradation is the decline in soil quality caused by its improper use usually for agricultural, pastoral, industrial or urban purposes. Soil degradation is a serious global environmental problem and may be exacerbated by climate change. It encompasses physical (soil erosion), chemical (salinity and alkalinity, pollution) and biological deterioration (pollution and deterioration of vegetal cover). Much of the soil erosion in India is caused by faulty methods of agriculture. Salinity and alkalinity have an adverse effect on soil and reduce soil fertility. Cultivation is not possible on saline soils unless they are flushed out with large quantities of irrigation water to leach out the salts. Choice of crops is limited to salinity-tolerant crops like cotton, barley etc. Quality of fodder and food produced is of poor quality.

Many countries are not capable to supply micronutrients for the requirement of their total population (Welch et al., 2002). Hence in present study organic waste has been selected for the enhancing productivity of plants.

Every nutrient such as nitrogen, potassium, phosphorus, sulphur, boron, calcium, carbon plays a functional role in different metabolic processes such as Photosynthesis, respiration etc (Fageria et al., 2008).

In organic waste the sedimentation rate of matter is very high. Due to this process mineralisation cycle is improved in soil, and it is beneficial for crops. It can enhance the soil fertility (Shibu et al., 2006; Reeves, 1997).

Methodology

- In Present study 3 crops were taken and 3 different organic wastes as amendments.
- Different vegetable crop such as Onion, Methi, Spinach has been used for Field trials.
- Green leafy waste, dung organic waste, Agricultural waste used as Organic Waste amendments for soil improvement.
- Biomass and Height of different vegetable crops evaluated by using organic waste such as Green leaf waste, Dung organic waste, Agricultural waste, (Mixture)Agricultural waste + dung waste.
- After maturation of plants in field the soil parameters were studied.
- Some important parameters were studied before and after amending the crops by organic wastes, which were studied by following procedures.

pH

pH is important parameter of soil. Low pH range makes crops accessible to some macronutrients (Nitrogen, Phosphorus between 6.5 to 7.5) and micronutrients (Iron, copper, Zink, Manganese, Cobalt, boron between 5.5 to 7)

Soil pH can be altered by amendments. Increasing organic matter will decrease pH (increase acidity) and hence it will make soil nutrient available for crops. Lime can be added to increase pH (increase alkalinity). Certain fertilizers are delivered as acidic or basic solutions.

Determined pH of the sample after establishing equilibrium between electrodes and sample. For buffered samples this can be done by dipping the electrode into a portion of the sample for 1 min. Blot dry, immerse in a fresh portion of the same sample, and read pH. With dilute poorly buffered solutions, equilibrate electrodes by immersing in three or four successive portions of the sample. Take a fresh sample to measure pH.

Electric conductivity (dS/m) or mS/cm

Electrical conductivity of soil is due to its ion exchange. Keeps balance of nutrients into the soil.
For determination of EC keep the conductometer electrode immersed in distilled water. Organic material coating can be removed with alcohol or acetone followed by washing with distilled water. Take the EC of soil solution sample.

OC (%)

Organic carbon is the amount of carbon that is stored in soil as an organic matter from dead plants and animal remains. Organic carbon is the basis of soil fertility. It is important component of soil and affects plant growth in two ways by releasing nutrients/triggers mineralization and as a source of energy. So, deficiency of carbon will affect productivity of ecosystem.

Method: Walkley and Black (titration method).

To determine OC, weigh 1 g of 0.2 mm soil sample into 500 ml conical flask. Add 10 ml 1 N Potassium dichromate. Add 20 ml Sulphuric acid (98%). Swirl a little and keep on an asbestos sheet for 30 minutes. Add 200 ml of Distilled water. Add 10 ml Orthophosphoric Acid (85%). Add 1 ml Diphenylamine Indicator. Titrate it with 0.5 N Ferrous Ammonium Sulphate.
Colour change: Black to Green. Note down the value at end point.

N (kg/ha)

Nitrogen is an essential macronutrient and plant needs it for many activities. The biomass and organic matters, amino acids and proteins. It ensures energy to plant. Nitrogen rich fertilizers being added to soil widely. Manure is a good natural source of Nitrogen. Atmospheric lightning and some microbes can fix Nitrogen into soil. If carbon is in access into soil, it will limit Nitrogen and that will cause Nitrogen deficiency. So, C/N ratio is important in plant growth. Nitrogen in in free form in soil as NO_3^- or $NH4^+$

Procedure:

Treatment of sample: Added 1 mL HCl to 50 mL clear/filtered sample, mix. Preparation of standard curve: Prepared calibration standards in the ranges of 0-7 mg NO3-N/L, by diluting to 50 mL the following volumes of standard solutions, added 1mL of HCl and mix.
Spectrophotometric measurements: Read absorbance or transmittance against re-distilled water set at zero absorbance or 100 % transmittance. Used a wavelength of 220 m to obtain NO_3^- reading and a wavelength of 275nm to determined interference due to dissolved organic matter.
Calculation for sample and standards, subtract 2 times the absorbance reading at 275nm, from the reading at 220nm to obtain absorbance due to $NO3^-$. Prepare a standard curve by plotting absorbance due to NO_3^- against NO_3^- concentration of standards. Obtain sample concentrations directly from standard curve, by using corrected sample absorbance.

P (kg/ha)

Phosphorous is an essential element which is classified as a macronutrient. Phosphorous is one of the nutrients added to soil. The phosphorous plays an important role in transferring energy. Organic compounds containing phosphorous are used to transfer energy from one reaction to drive another reaction. Phosphorous stimulates early plant growth and hastens maturity. Changing in levels of phosphorous affects the growth of algae. So, high level of phosphorous in water bodies favors excessive growth of algae which can be detrimental to aquatic life.

Method: Olsen, 1954.

To determine P, take 2.0 gm soil sample in 100 ml conical flask. Add 1 g of Activated charcoal. Add 40 ml 0.5 M Sodium bicarbonate (8.5 pH). Shake it for 30 min on a shaker machine. Filter through whatman filter paper no.1. Transfer 5 ml of clear and colorless filtrate in to a 25 ml volumetric flask. Add 5 ml of 1.5% Ammonium molybdate solution. Add distilled water to make the volume about 22 ml. Add 1 ml dilute Tin chloride solution. Make the volume to 25 ml. Read the color intensity at 660mm wavelength in spectrophotometer or colorimeter in red filter.

K (kg/ha)

Potassium (micro nutrient) helps plants to survive in droughts. It is important for water movement, other nutrients and enzyme activation.

To determine Potassium, add 25 ml 1 N Ammonium acetate (7.0 pH). for 5 minutes on a shaker machine. Filter through whatman filter paper no.1.Filter in 40ml cap, fennel cum test-tube. After reading flame photometer against about 12 standard working solution.

Results and Discussion:

Effect on soil after organic waste treatment while field trials:

Significant improvement in essential parameters of soil after treatment. There is positive changes in

Organic wastes	N (mg/g) (%)	P (mg/g) (%)	K (mg/g) (%)	pH	EC (mS/cm)
Green leaf waste	1.9	0.2	1	5	2.8
Dung organic waste	1.9	0.3	0.5	4	12
Agricultural waste	1	0.5	0.6	4	0.04

Table 1: Effect on soil after organic waste treatment

Characterization of different Organic wastes:

Organic wastes	N (mg/g) (%)	P (mg/g) (%)	K (mg/g) (%)	pH	C/N ratio	EC (mS/cm)
Green leaf waste	2.3	0.4	1.9	6.8	88.23	3.2
Dung organic waste	2.09	0.36	0.54	8.12	9.45	15.2
Agricultural waste	1.25	0.87	0.69	7.52	28	0.08
Agricultural waste + dung waste Biochar	3.12	0.84	1.5	7.36	50.20	3.82

Table 2: Characterization of different Organic wastes

Estimation of Total Biomass and Height of different Crops.

Agricultural waste + dung waste, Agricultural waste + dung waste biochar has been evaluated on three vegetable crops such as Onion *Trigonella foenum, graecum* (Methi), *Spinacia oleracea* (Spinach) for biomass and plant height. Result shows its effect on biomass plant height.

Estimation of Total Biomass and Height of Onion Crops.

Crop	Treatment	Mean		
		Plant fresh mass (Kg)	Plants dry mass (Kg)	Plant height (Cm)
Allium cepa (Onion)	Control	1.75 Kg	0.294 Kg	28 ± 8.3 Cm
	Green leaf waste	1.98 Kg	0.332 Kg	34 ± 5.4 Cm
	Dung organic waste	2.54 Kg	0.426 Kg	39 ±5.2 Cm
	Agricultural waste	2.21 Kg	0.371 Kg	37 ± 6.2 Cm
	Agricultural waste + dung waste Biochar	2.84 Kg	0.477 Kg	46 ± 6.2 Cm

Table 3: Estimation of Total Biomass and Height of Onion Crops

Estimation of Total Biomass and Height of Methi Crops.

Crop	Treatment	Mean		
		Plant fresh mass (Kg)	Plants dry mass (Kg)	Plant height (Cm)
Trigonella foenum-graecum (Methi)	Control	1.22 Kg	0.195 Kg	19 ± 6.0 Cm
	Green leaf waste	1.38 Kg	0.220 Kg	22 ± 9.1 Cm
	Dung organic waste	1.64 Kg	0.262 Kg	25 ± 4.2 Cm
	Agricultural waste	1.49 Kg	0.238 Kg	24 ± 5.1 Cm
	Agricultural waste + dung waste Biochar	1.69 Kg	0.270 Kg	31 ± 5.3 Cm

Table 4: Total Biomass and Height of Methi Crops.

Estimation of Total Biomass and Height of Spinach Crops.

Crop	Treatment	Mean		
		Plant fresh mass (Kg)	Plants dry mass (Kg)	Plant height (Cm)
Spinacia oleracea (Spinach)	Control	1.83 Kg	0.219 Kg	23± 7.2 Cm
	Green leaf waste	2.13 Kg	0.255 Kg	25 ± 5.3 Cm
	Dung organic waste	2.44 Kg	0.292 Kg	29±5.3 Cm
	Agricultural waste	2.51 Kg	0.301 Kg	32± 5.3 Cm
	Agricultural waste + dung waste Biochar	2.74 Kg	0.328 Kg	39 ± 4.2 Cm

Table 5: Estimation of Total Biomass and Height of Spinach Crops.

In the below picture **onion crop** with its field growth with different organic wastes has been shown. Other 2 crops Methi and Spinach were also studied for its biomass and productivity in 1MX1M during field trials

Agricultural waste+ Dung organic waste

Agricultural waste

Dung organic waste

Green leaf waste

Control

Picture: onion crop in control and different organic wastes amended soil

Characterization of organic waste reveals different dung has more basic pH i.e. 8.12. to neutralize dung pH and agricultural waste have pH near to neutral. Hence mixture of agricultural waste and dung has been created. Dung is used to improve nitrogen content in agricultural waste.

Biomass and Height of different vegetable crop such as Onion, Methi, Spinach has been evaluated by using organic waste such as Green leaf waste, Dung organic waste, Agricultural waste, Agricultural waste + dung waste biochar. The best result been observed in Agricultural waste + dung waste biochar. Study recorded significant improvement in soil properties

Present study will be very useful for improvement of soil properties and enhancing the nutrients in the soil. Soil properties are helpful for growth of plants. Study can be helpful for improving livelihood, enhancing local economy and designing policies for land improvements for future.

Conclusion

During green revolution India had become capable of its own food production. Our famers started using lots of fertilizer and pesticides. Due to heavy use of fertilizer and toxic pesticides to several issues stared. Many authors recommended use of natural practices such as organic farming, natural farming etc. they studied several aspects of organic farming and natural farming. But Kachchh has unique ecosystem in India. Most of studies for improvement of soil quality has been done for different ecosystem especially genetic plain, and peninsular region. Kachchh is least explored.

Present study reveals present soil status of agro-ecosystem of Kachchh and effect of different organic waste on vegetable crops. Designing experiment and suggestions in such a way so that a small land holder farmer can also adopt the strategy. Soil result reports Location A. B and C are crop fields for collection of soil samples. Location D is a forest area selected as a pristine site. Location C reflects.

Last decade many authors have used organic waste for the land treatment, enhancing nutrients composition and soil properties. (Odlare*et al*., 2011, Khaleel*et al*., 2011). Present study used green leafy waste, dung organic waste, Agricultural waste for soil improvement.

Large amount of organic waste are generated by both urban and rural set up. Many organizations are trying to bring awareness in people. Present study reveals agronomic use of organic wastes for enhancing the soil properties and use for productivity as well as use of biochar which has unique physiochemical properties which has received global attention recently. Study also elucidates clear agronomic function of biochar and its performance in elevating soil properties. Performance of different organic waste and biochar is compared. Results indicate use of biochar shows good performance and high agricultural value.

References

1. Shibu M., Leffelaar P., Van Keulen H. and Aggarwal P. 2006. Quantitative description of soil organic matter dynamics—a review of approaches with reference to rice-based cropping systems. Geoderma 137: 1-18.
2. Tellen, V. A., & Yerima, B. P. (2018). Effects of land use change on soil physicochemical properties in selected areas in the North West region of Cameroon. Environmental Systems Research, 7(1), 1-29.
3. Shrivastava, P., & Kumar, R. (2015). Soil salinity: a serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. *Saudi journal of biological sciences*, *22*(2), 123-131.
4. Assefa, F., Elias, E., Soromessa, T., & Ayele, G. T. (2020). Effect of changes in land-use management practices on soil physicochemical properties in Kabe Watershed, Ethiopia. Air, Soil and Water Research, 13, 1178622120939587
5. Bano, A., & Fatima, M. (2009). Salt tolerance in Zea mays (L). following inoculation with Rhizobium and Pseudomonas. *Biology and Fertility of Soils*, *45*(4), 405-413.
6. Steiner, C., Teixeira, W.G., Lehmann, J., Nehls, T., de Macedo, J.L.V., Blum, W.E.H.,Zech, W. (2007): Long term effects of manure, charcoal and mineral fertilization on crop production and fertility on a highly weathered Central Amazonian upland soil. Plant and Soil,291(1-2): 275-290.
7. Tabatabaei, S. J. (2006). Effects of salinity and N on the growth, photosynthesis and N status of olive (Olea europaea L.) trees. Scientia horticulturae, 108(4), 432-438.
8. Welch, R. M., & Graham, R. D. (2002). Breeding crops for enhanced micronutrient content. In *Food Security in Nutrient-Stressed Environments: Exploiting Plants' Genetic Capabilities* (pp. 267-276). Springer, Dordrecht.
9. Lehman, J., Da Silva Jr, J.P., Steiner, C., Nehls, T., Zech, W.and Glaser, B. (2003): Nutrient availability and leaching in an archaeological Anthrosol and a Ferralsol of the Central Amazon basin: fertilizer, manure and charcoal amendments. Plant and Soil, 249: 343-357.
10. Rady, M. M. (2012). A novel organo-mineral fertilizer can mitigate salinity stress effects for tomato production on reclaimed saline soil. South African Journal of Botany, 81, 8-14.
11. Wolf, B. (1971). The determination of boron in soil extracts, plant materials, composts, manures, water and nutrient solutions. *Communications in Soil Science and Plant Analysis*, *2*(5), 363-374.
12. Tabatabai, M. A. (1984). Importance of sulphur in crop production. *Biogeochemistry*, *1*(1), 45-62.
13. UNFCCC. 2015. Join the 4/1000 Initiative. Soils for Food Security and Climate. LimaParis, Action Agenda
14. Yan, D., Wang, D., & Yang, L. (2007). Long-term effect of chemical fertilizer, straw, and manure on labile organic matter fractions in a paddy soil. *Biology and Fertility of Soils*, *44*(1), 93-101.
15. Zalidis, G., Stamatiadis, S., Takavakoglou, V., Eskridge, K., & Misopolinos, N. (2002). Impacts of agricultural practices on soil and water quality in the Mediterranean region and proposed assessment methodology. *Agriculture, Ecosystems & Environment*, *88*(2), 137-146.
16. Blumenthal, J. M., Baltensperger, D. D., Cassman, K. G., Mason, S. C., & Pavlista, A. D. (2008). Importance and effect of nitrogen on crop quality and health. In *Nitrogen in the Environment* (pp. 51-70). Academic Press.
17. Woolf, D., Amonette, J.E., Street-Perrott, F.A., Lehmann,J. and Joseph. S. (2010): Sustainable biochar to mitigate global climate change. Nature Communications 1, Article number: 56 (online journal).
18. Chan, K.Y., Van Zwieten, L., Meszaros, I., Downie, A., Joseph, S.(2007): Agronomic values of greenwaste biochar as a soil amendment. Australian Journal of Soil Research 45, 629–634.
19. Haering, A., Dabbert, S., Offermann, F., & Nieberg, H. (2001, May). Benefits of organic farming for society. In *European Conference–Organic Good and Farming–Towards Partnership and Action in Europe, Copenhagen, Denmark* (pp. 10-11).
20. Truog, E. M. I. L. (1947). Soil Reaction Influence on Availability of Plant Nutrients 1. *Soil Science Society of America Journal*, *11*(C), 305-308.
21. Hessini, K., Issaoui, K., Ferchichi, S., Saif, T., Abdelly, C., Siddique, K. H., & Cruz, C. (2019). Interactive effects of salinity and nitrogen forms on plant growth, photosynthesis and osmotic adjustment in maize. Plant Physiology and Biochemistry, 139, 171-178.
22. Johnston A.E., Poulton P.R. and Coleman K. 2009. Soil organic matter: its importance in sustainable agriculture and carbon dioxide fluxes. Advances in agronomy 101: 1-57.
23. Scherer, H. W. (2001). Sulphur in crop production. European Journal of agronomy, 14(2), 81-111.
24. Smith, J. L., & Doran, J. W. (1997). Measurement and use of pH and electrical conductivity for soil quality analysis. *Methods for assessing soil quality*, *49*, 169-185.
25. McLean, E. O., Adams, D., & Franklin Jr, R. E. (1956). Cation exchange capacities of plant roots as related to their nitrogen contents. *Soil Science Society of America Journal*, *20*(3), 345-347.
26. Odlare, M., Arthurson, V., Pell, M., Svensson, K., Nehrenheim, E., & Abubaker, J. (2011). Land application of organic waste–effects on the soil ecosystem. *Applied Energy*, *88*(6), 2210-2218.
27. Panuccio, M. R., Chaabani, S., Roula, R., & Muscolo, A. (2018). Bio-priming mitigates detrimental effects of salinity on maize improving antioxidant defense and preserving photosynthetic efficiency. Plant Physiology and Biochemistry, 132, 465-

474. Richards, L. A. (1954). Diagnosis and improvement of saline and alkali soils: soil science. *United States Department of Agriculture Handbook*, *60*.
28. Rondon, M., Ramirez, A., Hurtado, M.(2004): Charcoal Additions to High Fertil-ity Ditches Enhance Yields and Quality of Cash Crops in Andean Hillsides of Columbia (CIAT Annual Report 2004). Cali, Colombia.
29. Sakamoto, Y., Watanabe, S., Nakashima, T., & Okano, K. (1999). Effects of salinity at two ripening stages on the fruit quality of single-truss tomato grown in hydroponics. The Journal of Horticultural Science and Biotechnology, 74(6), 690-693.
30. Munns, R. (2009). Strategies for crop improvement in saline soils. In *Salinity and water stress* (pp. 99-110). Springer, Dordrecht.
31. Sakr, M. T., El-Sarkassy, N. M., & Fuller, M. P. (2012). Osmoregulators proline and glycine betaine counteract salinity stress in canola. *Agronomy for sustainable development*, *32*(3), 747-754.
32. Rengasamy, P. (2006). World salinization with emphasis on Australia. *Journal of experimental botany*, *57*(5), 1017-1023.
33. Khaleel, R., Reddy, K. R., & Overcash, M. R. (1981). Changes in soil physical properties due to organic waste applications: a review. *Journal of environmental quality*, *10*(2), 133-141.
34. Lambe, T. (1955, January). The permeability of fine-grained soils. In *Symposium on Permeability of Soils*. ASTM International.
35. Reeves D. 1997. The role of soil organic matter in maintaining soil quality in continuous cropping systems. Soil and Tillage Research 43: 131-167
36. Lehmann, J., Rillig, M. C., Thies, J., Masiello, C. A., Hockaday, W. C., & Crowley, D. (2011). Biochar effects on soil biota–a review. *Soil biology and biochemistry*, *43*(9), 1812-1836.