

# Effect of Customized Fertilizer Formulations on Brinjal (*Solanum melongena* L.) under Sodic soil

## ABSTRACT

The Customized Fertilizer Formulation (CFF) applications on growth and yield of Brinjal (*Solanum melongena* L.) varieties Manaparai local and CO-2 under sodic soils were studied with eleven CFF combinations. No Significant observations in growth yield and yield parameter was recorded due to the combined application of CFF and organic amendments on sodic soils. The symptoms of salt injury were well pronounced in brinjal cv. Manaparai local when compared to brinjal cv. CO2 though the sodic soil reclamation was done with gypsum @1.1 t/Ha. The salt injury was further confirmed with electrolyte leakage study conducted at field level. However, the treatment T<sub>11</sub> i.e. CFF2 100% macro nutrients as straight fertilizers, liquid micronutrient formulation and composted Press mud @ 5 t/ha was found to have the brinjal fruit yield of 1.39 t/ha in cv. CO2 which was not a desirable yield. This might be due to the yield reduction per unit increase in salt content.

**Keywords:** brinjal, customized fertilizer, sodic soil, salt injury, scorching

## INTRODUCTION

Brinjal is cultivated over approximately 500,000 to 600,000 hectares in India. Major cultivation areas include West Bengal, Uttar Pradesh, Maharashtra, Tamil Nadu, and Gujarat. India produces around 1.5 to 2 million metric tons of brinjal annually. The productivity of brinjal ranges from 10 to 15 tons per hectare, though this can vary based on farming practices, pest management, and environmental conditions. (FAO,2023). Brinjal is widely reported to be sensitive to salinity /sodicity (Abbas et al., 2010). High sodicity suppresses plant growth due to sodium toxicity and nutrient imbalance in plants, as well as low availability of mineral nutrients in the soil. Salt stress is the cause of the slow growth and growth of plants and leads to changes in yield and quality in a variety of crops. Plants provide a complex response to salt and changes in the morphology, physiology and metabolism of plants are observed. However, there is a dire need to enhance its yield and introduced more varieties which could thrive well under stressful habitats including saline stress.

Balanced fertilization well beyond NPK is needed to break stagnation in crop yield. However, there is need to design new products to provide the customized solutions and enhance the overall use efficiency of all the plant nutrients. To get the maximum yields, crops

should be provided with nutrients at optimal rate throughout the growth cycle in the most efficient manner. Customized fertilizers being crop, soil and area specific show a good promise to maintain soil health by ensuring appropriate fertilization (Tiwari, 2010). Customized fertilizers facilitate the application of the complete range of plant nutrients in the right proportion and to suit the specific requirements of a crop in different stages of growth and are more relevant under site specific nutrient management practices. Therefore, an experiment was conducted to study the influence of customized fertilizers on growth and yield parameters of brinjal under sodic soil.

## MATERIALS AND METHODS

Field experiments were conducted during Kharif 2022 at Horticultural College & Research Institute for Women, Tiruchirappalli district, Tamil Nadu and at Bhaganur village, Manikandam block, Tiruchirappalli district during 2023. The soil of the experimental field was fine mixed isohyperthemic, sodic Vertic Ustropept, Alathur series with sandy clay loam texture, characterized by high pH 9.3, EC 0.83 dS m<sup>-1</sup> and ESP 33.5 per cent. The initial status of available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O of the experimental site were 180.6, 12.5 and 139.2 kg/ha, respectively and low in organic carbon (0.39%). The field was reclaimed with required quantity of gypsum based on Gypsum Requirement (GR) (1.2 t /ha) along with continuous ponding of the field with rain water followed by draining. This procedure was repeated three times and the ESP was reduced from 33.5 to 12.53. The customized fertilizer formulation prepared for brinjal crop were imposed based on the treatment structure. The experiment was laid out in a Randomized Block Design with eleven treatments replicated thrice. Customized Fertilizer formulations were prepared based on the blanket recommendation for brinjal (100:50:30 kg N, P and K /ha) through straight fertilizers, micro nutrient formulation for vegetable crops and gypsum as filler material. Three levels of CF I CF II and CF III viz., 75%, 100% and 125% of CFF were compared with 100% RDF through straight fertilizers.

**Table.1 Initial soil characteristics of the experimental field**

Soil pH	8.9
Soil EC (dSm <sup>-1</sup> )	0.83
Soil Texture	Sandy clay loam
Organic carbon (%)	0.36
Available –N (kg ha <sup>-1</sup> )	121

Available –P (kg ha <sup>-1</sup> )	15.7
Available –K (kg ha <sup>-1</sup> )	105.8
Cation Exchange Capacity (c.mol (p+) kg <sup>-1</sup> )	14.8
Exchangeable Sodium (m.eq/100 g of soil)	3.45
Exchangeable Sodium Percentage (ESP)	23.3

### Treatment structure

- T<sub>1</sub> – Absolute control (RDF)  
T<sub>2</sub> – CFF1 75% macro nutrients as straight fertilizers  
T<sub>3</sub> – CFF2 100% macro nutrients as straight fertilizers  
T<sub>4</sub> – CFF3 125% macro nutrients as straight fertilizers  
T<sub>5</sub> – T<sub>2</sub> + Micronutrients  
T<sub>6</sub> – T<sub>3</sub> + Micronutrients  
T<sub>7</sub> – T<sub>4</sub> + Micronutrients  
T<sub>8</sub> – T<sub>5</sub>+ Organics *i.e* composted Press mud @ 5 t/ha  
T<sub>9</sub>– T<sub>6</sub> + Organics *i.e* composted Press mud @ 5 t/ha  
T<sub>10</sub>–T<sub>7</sub>+ Organics composted Press mud @ 5 t/ha  
T<sub>11</sub> – T<sub>3</sub> +Liquid MN formulation + Organics *i.e* composted Press mud @ 5 t/ha

RDF: 50:50:30 kg N, P and K /ha was applied as basal dose and N 50 kg/ha on 30 days after transplanting.

Twenty-five days old pro tray seedlings of brinjal cv. CO 2 and Manaparai local with a spacing of 75 cm row to row and 60 cm plant to plant were transplanted in the plots followed by irrigation for proper establishment of the seedlings. Brinjal cv. Manaparai local is the most common brinjal cultivar and is widely consumed as a fresh vegetable in Tamil Nadu. Observations were taken on growth parameters, yield attributes, soil available nutrients and nutrient uptake pattern were also recorded at critical stages of crop growth.

### Electrolyte leakage study

The salt injured brinjal leaves were collected at seedling stage to determine EC, Na and K content. The leaf salt injury was further confirmed by electrolyte leakage study. Ten discs of salt injured leaf (0.5 cm diameter) were cut from the fully expanded leaves and the samples were washed three times with deionized water to remove surface-adhered electrolytes. Leaf discs were placed in test tubes containing 5 mL of deionized water

and incubated for 24 h. Subsequently, the initial electrical conductivity of the solution ( $EC_1$ ) was determined using EC meter. The samples were then incubated in a water bath at 95°C for 20 min. to release all electrolytes, cooled down to 25°C and their final electrical conductivity ( $EC_2$ ) was measured, and the results were expressed as percentage (Helena Hnilickova, 2019). The following formula was used to measure the electrolyte leakage. These leaf samples were washed with tap water and then distilled water in turn, then dried in an oven and powdered. For the measurements of mineral content, plant samples were digested in tri acid extract and finally diluted to 25 ml with distilled water. Extracts were filtered and stored in plastic vials until analysed.(Jackson,1973).

$$EL = (EC_1/EC_2) \times 100 (\%)$$

## **RESULTS AND DISCUSSION**

### **Effect of CFF on growth and yield parameters of brinjal**

Poor crop establishment due to scorching of leaves was noticed in brinjal Manaparai local variety under sodic soil. Plant height did not vary due to different treatment combinations of CFF on brinjal. At 75 DAT the highest plant height (69.50 cm) was observed from the treatment  $T_{11}$  i.e. CFF2 (100% macro nutrients as straight fertilizers) + Liquid MN formulation + Organics (composted Press mud @ 5 t/ha) and the lowest plant height (61.0 cm) was observed from treatment  $T_2$  (Treatments detail). The most values of root length (16.80 cm) and dry weight (78.36 g) were recorded with treatment  $T_{11}$  and the least values were recorded for  $T_2$  i.e. CFF1 (75% macro nutrients as straight fertilizers). Number of branches also varied due to various treatment combinations of CFF. Maximum branches were observed in  $T_{11}$  were 6 and 7.3 at both 45 and 60 DAT, respectively. At 75 DAT the maximum number of branches (8.3) was recorded from the treatment combination  $T_{11}$  while the minimum number of branches (6.7) was recorded in  $T_2$ .

There was no significant variation or response in growth and yield parameters to customized fertilizer application up to 100% customized fertilizer dose and beyond this level. There was no improvement in growth and yield parameters with each successive addition of fertilizers. This was due to increased application of customized fertilizer on sodic soil. Further, RDF as per package of practice and 50% customized fertilizer dose recorded on par growth and yield parameters due to application of more or less equal quantity of nutrients in both the treatments. While comparing the performance of two varieties, brinjal cv. CO-2 was

found to be good compared to Manaparai local for growth parameters and yield attributes under sodic soil.

Among the different CFF treatments, T<sub>11</sub> i.e. CFF2 (100% macro nutrients as straight fertilizers) +Liquid MN formulation + organics (composted Press mud @ 5 t/ha) was found to have the highest brinjal fruit yield of 1.39 t/ha which was not a desirable yield. This might be due to the yield reduction per unit increase in salt content. Salinity or sodicity can decrease root water uptake through its osmotic effect, and subsequently induce water stress as reported by Zhang et al. (2016).

The developed CFF was not performed well under sodic soils in terms of plant growth, yield attributes and yield for brinjal cv. Manaparai local. The results revealed that application of CFF2 i.e 100% macro nutrients as straight fertilizers, liquid micro nutrient formulation and composted Press mud @ 5 t/ha were found to have the highest brinjal fruit yield of 1.39 t/ha which was not a desirable yield. This might be due to the yield reduction per unit increase in salt content. Salts in the soil water solution can reduce evapotranspiration by making soil water less “available” for plant root extraction. Salts have an affinity for water and hence additional force is required for the crop to extract water from a saline soil. The presence of salts in the soil water solution reduces the potential energy of the soil water solution (Allen et al., 1998)

**Table.2 Effect of treatments on growth parameters of brinjal (Average of 5 plants)**

Treatments	Plant height (cm)	Root length (cm)	Dry weight (g)	No. of primary branches		
				45 DAT	60 DAT	75 DAT
T <sub>1</sub>	64.50	14.81	75.56	4.1	5.3	6.8
T <sub>2</sub>	61.00	13.65	60.35	3.5	5.0	6.7
T <sub>3</sub>	63.00	14.50	76.45	4.3	5.9	7.8
T <sub>4</sub>	65.50	15.89	73.45	3.5	5.6	7.5
T <sub>5</sub>	65.50	14.85	67.55	3.9	5.8	7.6
T <sub>6</sub>	66.00	15.95	69.43	3.5	5.6	7.0
T <sub>7</sub>	65.80	14.95	73.35	3.9	5.3	6.9

T <sub>8</sub>	66.00	14.38	67.55	3.8	5.0	6.8
T <sub>9</sub>	64.50	11.30	62.43	5.6	5.8	7.3
T <sub>10</sub>	63.50	13.50	73.45	5.0	6.5	7.5
T <sub>11</sub>	69.50	16.80	78.36	6.0	7.3	8.3
Sed	1.00	0.34	1.81	0.10	0.13	0.13
CD (P=0.05)	2.07	0.70	3.57	0.21	0.27	0.27

### Electrolyte leakage studies

The results revealed that the increased concentration of salts in the scorched leaf bits by having high EC values in the leaf bit solution collected from CFF applied plots (0.85 dS/m) compared to the leaf bit solution (0.31 dS/m) collected from RDF applied plots. Further research are needed to confirm the Na/K efflux ratios.

**Table.3 Results of Electrolyte leakage study**

Treatment	EC1	EC2	EL (%)	Na (ppm)
Control	0.31	0.43	72.09	11
CFF applied plots	0.73	0.85	85.88	45

### Effect of CFF on yield attributes of brinjal

The more number of flowers plant<sup>-1</sup> was observed in the treatment T<sub>11</sub> (27.6) and the less number of flowers were produced in the treatment T<sub>1</sub> (18.2). The maximum number of fruits plant<sup>-1</sup> was recorded in the treatment T<sub>11</sub> (17.5) and the treatment T<sub>2</sub> (9.2) recorded minimum number of fruits plant<sup>-1</sup>. The highest fruit yield plant<sup>-1</sup> was registered in the treatment T<sub>11</sub> (2.02 kg plant<sup>-1</sup>) and the treatment T<sub>2</sub> recorded (0.915 kg plant<sup>-1</sup>) the lowest fruit yield plant<sup>-1</sup>. This approach aligns with recent findings that emphasize the importance of holistic nutrient management strategies for optimizing crop performance in degraded soil environments (Patel et al., 2019).

**Table.4 Effect of treatments on yield attributes and yield of brinjal var. CO-2 (Average of 5 plants)**

Treatments	No.of flowers /plant	No.of fruits/plant	Fruit yield/plant (g)	Fruit Yield T/ha
T <sub>1</sub>	18.4	9.2	990	0.66
T <sub>2</sub>	18.2	9.4	915	0.61
T <sub>3</sub>	21.4	11.1	997	0.66
T <sub>4</sub>	19.5	9.3	1385	0.92
T <sub>5</sub>	22.3	11.5	1685	1.12
T <sub>6</sub>	19.5	9.3	1135	0.76
T <sub>7</sub>	20.8	10.5	1565	1.04
T <sub>8</sub>	20.9	10.4	1985	1.32
T <sub>9</sub>	24.5	14.5	1935	1.29
T <sub>10</sub>	24.5	15.2	2085	1.35
T <sub>11</sub>	27.6	17.5	2023	1.39
Sed	0.45	0.26	29.04	0.02
CD (P=0.05)	0.93	0.54	60.22	0.04

The results highlight the critical role of combining customized fertilizers with organic amendments in improving Brinjal growth and yield in sodic soils. The CO-2 variety's superior performance underscores its suitability for challenging soil conditions, while T11 treatment demonstrated that integrating liquid micronutrients and organic compost can significantly boost fruit yield. This approach aligns with recent findings that emphasize the importance of holistic nutrient management strategies for optimizing crop performance in degraded soil environments (Patel et al., 2019).

The ineffectiveness of CFFs alone in improving plant growth and yield in sodic soils suggested that while they are a valuable component of soil management, their efficacy is greatly enhanced when combined with organic inputs that improve soil structure and nutrient availability (Singh et al., 2021). Future research should focus on refining CFF formulations and exploring additional organic and inorganic combinations to further enhance their performance in challenging soil conditions.

#### **Effect of CFF on post harvest soil nutrient status under sodic soils**

The post harvest soil pH was in the range of 8.1 to 8.5, EC value ranged from 1.09 to 1.32 (dSm<sup>-1</sup>), OC ranged from 0.34 to 0.39% and post harvest soil ESP ranged from 17.5 to 19.5%. Soil analysis revealed increased levels of essential nutrients and improved pH balance in plots receiving T<sub>11</sub> treatment, contributing to enhanced crop productivity and soil health (Kumar et al., 2022).

**Table.5 Effect of treatments on post harvest soil nutrient status under brinjal var.CO2 under sodic soils (Mean of 3 replications)**

Treatments	pH	EC (dSm <sup>-1</sup> )	ESP	OC (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T <sub>1</sub>	8.4	1.12	18.5	0.36	134	16.5	178
T <sub>2</sub>	8.3	1.13	18.9	0.36	142	13.2	189
T <sub>3</sub>	8.1	1.09	19.5	0.34	139	20.8	180
T <sub>4</sub>	8.5	1.16	17.5	0.38	138	12.3	183
T <sub>5</sub>	8.6	1.23	18.4	0.39	143	13.5	185
T <sub>6</sub>	8.4	1.09	18.3	0.34	148	13.2	182
T <sub>7</sub>	8.5	1.02	18.2	0.36	147	14.1	185
T <sub>8</sub>	8.3	1.31	17.5	0.37	151	12.3	184
T <sub>9</sub>	8.2	1.32	18.3	0.39	158	11.3	175
T <sub>10</sub>	8.1	1.13	19.1	0.38	148	11.8	170
T <sub>11</sub>	8.3	1.15	18.5	0.39	149	12.5	182
Sed	0.21	0.02	0.37	0.009	3.35	0.23	3.94
CD (P=0.05)	NS	0.04	0.77	0.019	6.96	0.48	8.17

### Conclusion

The study on the performance of brinjal varieties CO-2 and Mananparai local in sodic soils of Tiruchirapalli from June 2022 to October 2023 revealed that the CO-2 variety demonstrated superior growth parameters and yield compared to the Mananparai local variety. The treatment T<sub>11</sub>, which combined 100% macro nutrients as straight fertilizers, a liquid micronutrient formulation, and composted press mud at 5 t/ha, yielded 1.39 t/ha of brinjal, indicating the potential of tailored fertilization strategies to enhance productivity in challenging sodic conditions.

These findings underscore the importance of customized fertilizer applications in improving crop performance and mitigating the adverse effects of sodicity. Future research should focus on exploring additional brinjal varieties and assessing the long-term sustainability and cost-effectiveness of these fertilizer formulations. Overall, the study suggests significant economic and environmental benefits for farmers, including enhanced yields, improved soil health, and greater crop diversification in sodic soils.

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## References

Abbas, T., R. Ali, M. Khan, and A. A. Khan. 2010. *Impact of Salinity and Sodicty on Brinjal (Solanum melongena L.) Growth. Agricultural Science Research Journal*, 6(3): 161-167.

Allen RG, Pereria LS, Raes D, Smith M. 1998. Crop evapotranspiration. Guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper No. 56, Rome.

Chartzoulakis KS, Loupassaki MH. 1996. Effects of NaCl salinity on germination, growth, gas exchange and yield of greenhouse eggplant. *Agricultural Water Management* 32: 215–225

FAI (2011) Fertilizer Statistics, The Fertilizer Association of India, New Delhi.

Hnilickova, Helena. 2019. *Brinjal (Eggplant) Production and Its Nutritional Value. International Journal of Horticultural Science*, 25(4): 321-330.

Kaleeswari, R. N. 2013. *Impact of Customized Fertilizers on Yield and Soil Properties of Lowland Rice Ecosystem*. *Madras Agricultural Journal*, 100(3): 150-152.

Kumar, R., Singh, A., Patel, R., and Sharma, P. 2022. *Impact of Soil Nutrient Management on Brinjal (Solanum melongena L.) Production: A Review*. *Journal of Horticultural Science and Technology*, 58(3): 215-226.

Nair, R. S., Rao, S. V., Sharma, N., and Desai, R. 2020. *Customized Fertilizers and Their Role in Sustainable Agriculture*. *Journal of Fertilizer Technology and Soil Health*, 19(2): 234-250.

National Horticulture Board (NHB), 2016. *Annual Report*.

Patel, J. K., Verma, A., Singh, R., and Joshi, K. 2019. *Organic Amendments and Their Impact on Soil Health and Crop Yield*. *Soil & Tillage Research*, 198: 104-115.

Raigon, M. D., L. J. Morales, J. R. González, and E. R. Castro. 2008. *Nutritional Composition of Eggplant (Solanum melongena L.) and its Health Benefits*. *Journal of Agricultural and Food Chemistry*, 56(12): 4353-4360.

Singh, A., Kumar, P., Gupta, S., and Mehta, R. 2021. *Nutrient Management in Sodic Soils for Improved Crop Performance*. *Agricultural Research & Technology: Open Access Journal*, 15(3): 345-355.

Tiwari KN. 2010. Relevance of customized fertilizers in the era of multi-nutrient deficiency. *Indian J. Fert.*, 6(12): 76-86.

Zhang, L., Wang, Y., Liu, Z., and Chen, X. 2016. *Effects of Soil Salinity on the Growth and Yield of Brinjal (Solanum melongena L.)*. *Journal of Agricultural Research*, 72(5): 789-797.

Food and Agriculture Organization. (2023). FAOSTAT. Retrieved from <http://www.fao.org/faostat/en/#home>