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Effect of TNAU Customized Fertilizer on Sustaining Soil Fertility and Enhancing the Maize Yield

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Customized fertilization for specific crops can provide the solutions to get the maximum yields and enhance the overall use efficiency of all the plant nutrients. A field experiment was conducted to study the effect of TNAU customized fertilizer mixture on yield, nutrient uptake of maize and on soil fertility with 6 treatments in randomized block design. The treatments included the application of 120 kg Urea ha^{-1} + 50 kg DAP ha^{-1} as Farmers' practice (T_1), Farmers' practice (T_1) with micronutrient mixture @ 15 kg ha^{-1} as EFYM (T_2), Recommended dose of fertilizers (NPK alone) (T_3), CF1 (Customized fertilizer) -RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} as EFYM (T_4), CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as straight chemical fertilizers (T_5) and CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6). The dry matter production, yield parameters, grain and straw yield of maize recorded the highest in CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6) and the grain yield was 32% higher than the farmers' practice. The nutrient uptake of macro and micro nutrients recorded higher in the above mentioned treatment followed by application of RDF (NPK) with TNAU micronutrient mixture @ 15 kg ha^{-1} as EFYM (T_4). The application of CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6) has registered the increased the availability of macro and micro nutrients instead of depleting the soil fertility even after the harvest of crop. From the results, it is concluded that the application of CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6) for maize can maximize the yield with higher net profit.

Key words: Customized fertilizer, Mixture, Yield, Nutrient uptake, EFYM, Soil fertility, Dry matter production, Available nutrients

Maize (*Zea mays* L.) is the third most important cereal next to rice and wheat, in India. It is a versatile crop and can be grown throughout the country under diverse environments. It is cultivated over an area of about 9.4 million ha with a production of about 24.35 million T with an average productivity of 2.41 t ha^{-1} of grain (Agricultural statistics at a glance-2014). The current trends show that the marginal productivity of soil in relation to the application of fertilizers is declining. The main causes for low and declining crop response to fertilizers are: a) continuous use of fertilizer N alone or with inadequate P and K application leading to mining of native soil P and K; b) continued practice of intensive cropping systems with high yielding varieties even under recommended NPK use; c) use of high analysis fertilizers devoid of secondary and micronutrients leading to imbalanced fertilization. Per hectare consumption of fertilizers is still imbalanced and inadequate and mining of nutrients from the soils continues to take place at an alarming rate resulting in depletion of soil fertility. Balanced fertilization well beyond NPK is needed to break stagnation in crop yield. Integrated Nutrient Management (INM) is an alternate option to increase the yield and to maintain the soil productivity which aims at efficient and judicious use of all the major sources of plant nutrients in an integrated approach so as to get maximum economic yield without any deleterious effect on physico-chemical and biological properties of the soil (Balasubramaniyan and Palaniappan, 2001). The application of FYM will positively interact with the inorganic fertilizers and formation of metal chelates and thus protecting them from adsorption and fixation in the soil which is the vital component of INM (Lee, 1985). However, there is a 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. In these contexts only, customized fertilizer formulation has been created with inclusion of micronutrient mixture enriched with FYM and without. Hence the present study was conducted to know the effect of different doses of customized fertilizer on yield, nutrient uptake of maize and on soil fertility.

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Materials and Methods

A field experiment was conducted at Maize Research Station, Vagarai, Dindigul district. The experiment was composed of six treatments in randomized block design. Hybrid maize (CO H (M) 5) was sown on the side of the ridges by adopting a spacing of 60X30 cm at a depth of 5 cm. The recommended dose of fertilizer (RDF) for hybrid maize was 250:75:75 N, P_2O_5, K_2O kg ha^{-1}. Nitrogen was applied in three splits *viz*., 25: 50: 25 per cent as basal, 25 and 45 DAS, respectively. The entire dose of phosphorus was applied basally. The potassium was applied in two equal split doses *viz.*, basal and at 45 DAS. The N, P and K fertilizers were applied in the form of urea (46 % N), single super phosphate (16 % P_2O_5) and muriate of potash (60 % K_2O), respectively. Cultivation practices were followed as per the guidance of Crop Production Guide for Tamil Nadu (CPG, TNAU, 2012).

The micronutrient mixture has been formulated by mixing Iron sulphate, Copper sulphate, Zinc sulphate, Manganese sulphate and Sodium molybdate. The micronutrient enriched farm yard manure was made by physical mixing of the micronutrient fertilizer mixture with the organic manure at friable moisture in 1: 10 ratio and incubated for one month and then used for field application. The treatments details and details of TNAU micronutrient mixture are given in Table 1 & 2 respectively. The soil samples were examined for available nutrient content with frequent intervals at knee high stage, tasseling and after harvest. Plant nutrient uptake also determined based on the following equation.

$$\text{Nutrient uptake} = \frac{\text{Per cent of nutrient content}}{100} \times \text{Total dry matter}$$

Results and Discussion

Initial soil properties

The soil of the experimental site was sandy clay loam, non-saline and neutral in pH. The organic carbon content of the soil was low (0.32 %). The available nutrient status of experimental soil was low in available nitrogen (174.7 kg ha^{-1}), medium in available phosphorus (19.72 kg ha^{-1}) and high in available potassium (780.2 kg ha^{-1}). Regarding micronutrient status of experimental soil it was sufficient in available copper (1.46 mg kg^{-1}) and manganese (2.67 mg kg^{-1}) and deficient in iron (1.92 mg kg^{-1}) and zinc (0.29 mg kg^{-1}).

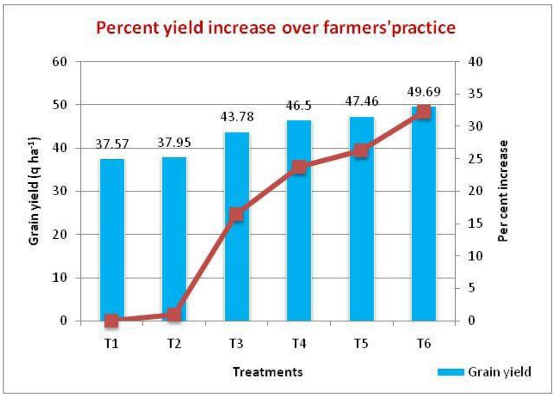

Fig.1. Influence of customized fertilizer on maize grain yield

Table 1. Treatment details of the experiment

T_1	Farmers' practice (Basal application of 50kg Urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T_2	Farmers' practice with micronutrient mixture @ 15 kg ha^{-1} as EFYM
T_3	RDF
T_4	CF1- RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} for hybrid as enriched farm yard manure
T_5	CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as straight chemical fertilizer
T_6	CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as enriched farm yard manure

CF – Customized formulation of fertilizers
RDF – Recommended dose of fertilizer
EFYM – Enriched Farm Yard Manure

Effect of fertilizer mixture application on Soil available nutrients

Available nitrogen

Soil available nitrogen status was estimated at different crop growth stages such as knee high, tasseling and after harvest. It was ranged between 164.9 and 339.6, 161.5 and 329.5 and 160.1 and 288.5 kg ha^{-1} respectively. The highest soil available nitrogen content was observed with the CF3- RDF+ TNAU micronutrients mixture (T_6) @ 30 kg ha^{-1} as EFYM. Higher availability could be due to the direct contribution of nitrogen supply through organics as well as increased microbial activity and partial pressure of carbon dioxide in the micronutrient enriched treatment, resulting in an enhanced release of native N sources (Sawargaonkar *et al.,* 2008). A marked decline in the availability of macro and micronutrients in the soil was observed with the advancement of crop growth period might be due to the continuous removal of nutrients by the crop and loses due to fixation and leaching. This result was in line with the findings of Amujoyeghe *et al.*, 2007.

Table 2. Details of TNAU micronutrient mixture

TNAU Micronutrient mixtures (kg /100 kg mixture)	
Iron sulphate (Fe SO_4)	39.5
Manganese sulphate (Mn SO_4)	8.2
Zinc sulphate (Zn SO_4)	23.8
Copper sulphate (Cu SO_4)	5.2
Borax	11.9
Sodiym molybdate	1
Filler	11.3

Available phosphorus

Available phosphorus content of the experimental soil was ranged from 23.37 to 33.67, 20.26 to 28.25 and 18.95 to 25.18 kg ha^{-1} at knee high, tasseling and at harvest stages respectively (Table 3). Application of macronutrients with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6) recorded the highest available P content irrespective of the stages of the crop. It was followed by the application of TNAU micronutrient mixture @ 15 kg ha^{-1} as EFYM (T_4). With advancement of crop growth, the P availability got reduced due to P fixation. But in the micronutrient applied treatments, the enrichment of FYM improves the P availability by reducing the P fixation in soil by the formation of organo metal chelates with the organic manures (Senthil kumar *et al.*, 2004).

Table 3. Effect of fertilizer mixture on Soil available N, P and K at different stages of crop growth (kg ha^{-1})

Treatments	Nitrogen			Phosphorus			Potassium		
	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest
T_1	164.9	161.5	160.1	23.37	20.26	18.95	768.5	757.3	740.5
T_2	224.6	216.9	214.6	26.87	23.97	21.87	791.8	776.8	761.1
T_3	279.5	274.5	264.0	29.35	23.65	21.37	824.9	812.7	805.0
T_4	286.8	274.9	266.9	31.04	25.51	21.63	850.8	838.0	826.5
T_5	291.9	278.3	272.2	31.09	26.49	23.61	861.8	847.8	832.1
T_6	339.6	329.5	288.5	33.67	28.25	25.18	912.0	897.2	852.4
SEd	6.1	3.4	8.1	1.23	0.76	1.66	7.9	7.5	6.0
CD(0.05)	12.9	6.9	14.4	2.68	1.65	3.62	17.4	16.4	13.2

T1 – Farmers' practice (Basal application of 50kg Urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T2 – Farmers' practice with micronutrient mixture @ 15 kg ha^{-1} as EFYM
T3 - RDF
T4 – CF1- RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} for hybrid as enriched farm yard manure
T5 – CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as straight chemical fertilizer
T6– CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as enriched farm yard manure

Available potassium

Soil available potassium was ranged between 768.5 and 912, 757.3 and 897.2, 740.5 and 852.4 kg ha^{-1}. The highest availability of potassium was observed in the treatment T_6 as well as the lowest in T_1. Invariably in all the treatments the availability of potassium was high since the initial soil has high potassium content. The increased available K might be due to intrinsic properties of soil or either by the application of fertilizers. Even though, the soil has more amount of available K, the macronutrients with micronutrients were applied as priming dose which will enhance the availability of K to the crop (Sekhon and Singh, 2013).

Table 4. Effect of fertilizer mixture on Soil available of Fe, Zn, Cu and Mn at different stages of crop growth (kg ha^{-1})

Treatments	Iron			Zinc			Copper			Manganese		
	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest
T_1	1.83	1.67	1.56	0.267	0.249	0.237	1.45	1.41	1.37	2.13	2.03	2.02
T_2	2.29	2.20	2.03	0.372	0.355	0.323	1.54	1.48	1.46	3.44	3.08	3.06
T_3	1.39	1.33	1.13	0.236	0.212	0.208	1.44	1.39	1.36	2.13	2.07	2.04
T_4	3.05	3.03	2.14	0.481	0.440	0.420	2.07	1.96	1.72	4.43	4.34	4.22
T_5	3.18	3.11	2.31	0.581	0.545	0.514	2.02	1.78	1.70	4.69	4.65	4.51
T_6	3.58	3.37	3.02	0.597	0.546	0.520	2.45	2.08	1.96	4.89	4.86	4.79
SEd	0.08	0.05	0.14	0.029	0.024	0.015	0. 1	0.11	0.06	0.13	0.08	0.35
CD(0.05)	0.17	0.11	0.30	0.062	0.052	0.033	0.22	0.24	0.13	0.29	0.17	0.77

T1 – Farmers' practice (Basal application of 50kg Urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T2 – Farmers' practice with micronutrient mixture @ 15 kg ha^{-1} as EFYM
T3 - RDF
T4 – CF1- RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} for hybrid as enriched farm yard manure
T5 – CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as straight chemical fertilizer
T6– CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as enriched farm yard manure

Available micronutrients

DTPA extractable soil available micronutrients were analysed. Due to application of micronutrient mixture, the availability of micronutrients was increased at different crop growth stages. The iron availability ranged between 1.83 to 3.02 ppm, zinc 0.267 to 0.520 ppm, copper 1.45 to 1.96 ppm and manganese 2.03 to 4.79 ppm. Initially the availability of micronutrients increased but with the advancement of crop stages, the availability tend to reduce. The Iron and Zinc availability in post harvest soil has been doubled by the application of enriched FYM which will ultimately improve the production of succeeding crop. The highest availability of micronutrients was recorded in CF3- application of macronutrients with micronutrients @ 30 kg ha^{-1} as EFYM (T_7) at all crop growth stages. Since, the applied FYM might be positively interacted with the inorganic fertilizer nutrients which are essentials to produce the organic acid and formation of metal chelates and thus protecting them from adsorption and fixation in the soil, conjoint application of organics with inorganic micronutrient fertilizers enhanced the availability of micronutrient cations in the soil (Kumar *et al.,* 2003). Copper and zinc may have interactions among them based on the crop species, soil and fertilizer properties (Barker and Pilbeam, 2007).

Table 5. Effect of customized fertilizer application on DMP, Grain and straw yield of maize (q ha^{-1})

Treatments	30 DAS	60DAS	Harvest	Straw yield	Grain yield	Per cent yield increase over farmers practice
T_1	7.73	48.57	103.90	64.84	37.57	-
T_2	8.14	51.52	104.45	66.53	37.95	1.01
T_3	8.77	56.88	111.50	67.71	43.78	16.53
T_4	9.01	59.08	115.25	68.78	46.50	23.77
T_5	9.12	60.04	117.45	70.99	47.46	26.32
T_6	9.42	60.70	120.00	72.79	49.69	32.26
SEd	0.05	0.44	1.75	1.36	0.79	
CD(0.05)	0.11	1.65	3.75	2.92	1.65	-

T1 – Farmers' practice (Basal application of 50kg Urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T2 – Farmers' practice with micronutrient mixture @ 15 kg ha^{-1} as EFYM
T3 - RDF
T4 – CF1- RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} for hybrid as enriched farm yard manure
T5 – CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as straight chemical fertilizer
T6– CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as enriched farm yard manure

Dry Matter Production (DMP)

The dry matter production was significantly increased with the advancement of crop stages (Table 5) and ranged between 7.73 to 9.42, 48.57 to 60.7, 103.9 to 120.0 q ha^{-1} at knee high, tasseling and at harvest stage respectively. The DMP was high under CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6). This might be due to increased NPK and micronutrients uptake by maize, which directly attributed to the better rooting and development through better utilization of photosynthesis, resulted in an increased biomass (Mahajan *et al.,* 2011). At all stages of crop growth, farmers' practice (T_1) registered the lowest dry matter production.

Table 6. Effect of customized fertilizer application on Yield attributes of maize

Treatments	Cob length (cm)	Cob girth (cm)	Number of rows / cob	Number of grains /cob rows	100 grain weight (g)
T_1	16.12	13.24	13.83	34.67	34.48
T_2	16.52	13.52	14.67	35.33	35.88
T_3	17.50	13.83	14.83	38.00	36.57
T_4	17.85	14.10	15.25	38.33	36.90
T_5	18.30	14.37	15.67	38.67	37.76
T_6	19.23	14.99	17.00	40.34	39.76
SEd	0.63	0.32	0.82	0.83	1.00
CD (0.05)	1.39	0.68	1.36	1.81	2.17

T1 – Farmers' practice (Basal application of 50kg Urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T2 – Farmers' practice with micronutrient mixture @ 15 kg ha^{-1} as EFYM
T3 - RDF
T4 – CF1- RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} for hybrid as enriched farm yard manure
T5 – CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as straight chemical fertilizer
T6– CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as enriched farm yard manure

Yield parameters

The yield attributes like cob girth, cob length, number of rows per cob, number of grains per row and 100 grains weight were significantly influenced by application of customized fertilizers (Table 6). Cob length and cob girth ranged between 16.12 to 19.23 cm and 13.24 to 14.99 cm, respectively. Number of rows per cob and number of grains per row ranged between 13.83 to 17.00 and 34.67 to 40.30 respectively. 100 grain weight of hybrid maize was ranged between 34.48 g to 39.76 g. Yield parameters were registered higher in application of RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as EFYM (T_6) than all the rest of treatments. Invariably, all the yield parameters recorded the lowest yield value recorded in farmers' practice. The increased yield parameters of hybrid maize might be due to combined application of micronutrients with major nutrients which ultimately enables the plant to synthesis sufficient photosynthates (El-Nagar, 2002). The results also revealed that number of rows per cob has not shown significant variations among the treatments.

Table 7. Effect of customized fertilizer application on total uptake of N, P, K at different stages of crop growth (kg ha^{-1})

Treatments	Nitrogen				Phosphorus				Potassium			
	Knee high	Tasseling	Harvest		Knee high	Tasseling	Harvest		Knee high	Tasseling	Harvest	
			Straw	Grain			Straw	Grain			Straw	Grain
T_1	11.15	61.42	121.06	55.10	3.19	12.42	24.95	18.25	8.29	54.37	99.57	35.17
T_2	11.86	64.75	118.85	56.99	3.31	13.49	26.14	18.87	9.71	64.24	111.19	36.98
T_3	13.21	79.70	146.84	67.30	3.62	16.80	29.1	21.77	11.04	71.84	119.53	42.64
T_4	14.11	89.45	158.45	74.48	3.75	18.69	31.45	24.38	15.42	93.77	159.31	46.46
T_5	13.85	86.36	152.4	77.36	3.68	18.01	30.39	25.60	12.88	76.82	130.09	48.74
T_6	14.78	91.54	163.12	80.75	3.87	19.17	32.13	26.95	18.32	103.34	202.93	51.26
SEd	0.11	0.94	2.75	0.24	0.08	0.36	0.58	0.10	0.26	2.70	6.16	0.15
CD (0.05)	0.24	2.06	5.98	0.52	0.18	0.78	1.27	0.22	0.56	5.88	13.41	0.33

T1 – Farmers' practice (Basal application of 50kg Urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T2 – Farmers' practice with micronutrient mixture @ 15 kg ha^{-1} as EFYM
T3 - RDF
T4 – CF1- RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} for hybrid as enriched farm yard manure
T5 – CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as straight chemical fertilizer
T6– CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as enriched farm yard manure

Grain and straw yield

The grain yield of hybrid maize ranged between 37.57 to 49.69 q ha^{-1}. The highest grain yield was recorded in the treatment CF3-RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6). The yield increase of maize in the above mentioned treatment was 32 per cent higher when compared to farmers' practice (T_1) (Fig.1). The increase in yield was probably due to effective utilization of applied nutrients, increased sink capacity and nutrient uptake by crop. The yield potential of maize is mainly governed by the growth and yield components. The positive and significant improvement in yield attributes and nutrient uptake would have resulted in enhanced grain yield. Straw yield of hybrid maize ranged between 64.84 to 72.79 q ha^{-1}. Straw yield of hybrid maize also recorded the highest in the T_6 as that of grain yield. The increased yield might be due to the higher availability of macro and micro nutrients for crop development (Omaraj Meena *et al*., 2007).

Nutrient uptake

The application of different mixtures brought out significant effect on nutrient uptake by maize. Nutrient content and dry matter production was observed at different crop stages such as knee high, tasseling, and at harvest stage (grain and straw). Nitrogen uptake ranged between 11.15 and 14.78 kg ha^{-1}, 61.42 and 91.54 kg ha^{-1}, 121.06 and 163.12 kg ha^{-1} and 55 and 80.7 kg ha^{-1} at knee high, tasseling, and at harvest stage as straw uptake and grain uptake respectively. Irrespective of stages, application of CF3- RDF with micronutrient mixture (TNAU formulation) @ 30 kg ha^{-1} as EFYM (T_6) recorded the highest N uptake which might be due to the higher utilization of N from soil for growth and development of the crop and might have synergistic effect between macro and micronutrient addition on enhanced root growth, nitrogen availability and biochemical mechanisms within the plant (Hani *et al*., 2006). Phosphorus uptake ranged between 3.19 and 3.87, 12.42 and 19.17, 24.95 and 32.13 and 18.25 and 27.0 kg ha^{-1} for knee high, tasseling, and at harvest stage as straw and grain respectively. At all stages, the highest P uptake was recorded in the application of RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6). The application of EFYM might have favoured the solubility and availability of the soil native

P, thereby increasing the P index in the crop. The results clearly stated the positive influence of nutrient concentration on the proliferation of root growth and development of root system, for better uptake of P at different stages. Similar result was observed by Prabha (1995). Potassium uptake was ranged between 8.29 and 18.32, 54.37 and 103.34, 99.57 and 202.93 and 35.1 and 51.3 kg ha^{-1} for knee high, tasseling, and at harvest stage as straw and grain respectively. The highest potassium uptake was seen in the application of RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6). Viator *et al.* (2002) revealed that the probable reason could be increased K supply, split application, release of K in soil and synergistic relationship between macro and micronutrients.

Table 8. Effect of customized fertilizer application on total uptake of Fe and Zn at different stages of crop growth (kg ha^{-1})

Treatments	Iron				Zinc			
	Knee high	Tasseling	Harvest		Knee high	Tasseling	Harvest	
			Straw	Grain			Straw	Grain
T_1	0.095	0.489	0.867	0.317	0.029	0.153	0.301	0.093
T_2	0.104	0.533	0.979	0.355	0.033	0.172	0.321	0.106
T_3	0.107	0.623	0.937	0.378	0.032	0.193	0.322	0.110
T_4	0.129	0.786	1.197	0.436	0.041	0.270	0.437	0.129
T_5	0.123	0.737	1.115	0.467	0.038	0.250	0.412	0.139
T_6	0.141	0.827	1.25	0.492	0.045	0.289	0.465	0.147
SEd	0.001	0.007	0.019	0.001	0.0003	0.004	0.01	0.001
CD (0.05)	0.002	0.016	0.04	0.003	0.001	0.008	0.023	0.002

T1 – Farmers' practice (Basal application of 50kg Urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T2 – Farmers' practice with micronutrient mixture @ 15 kg ha^{-1} as EFYM
T3 - RDF
T4 – CF1- RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} for hybrid as enriched farm yard manure
T5 – CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as straight chemical fertilizer
T6– CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as enriched farm yard manure

The micronutrients uptake like iron, zinc, copper and manganese were recorded at different stages of maize crop growth. With the advancement of the crop the uptake of iron increased tremendously. It was ranged from 0.095 to 0.141 kg ha^{-1} at knee high stage, 0.489 to 0.827 kg ha^{-1} at tasseling stage and at harvest stage, the uptake was recorded for straw and grain individually. They were ranged between 0.867 and 1.25 kg ha^{-1}, 0.317 and 0.492 kg ha^{-1} for straw and grain respectively. Zinc uptake

Table 9. Effect of customized fertilizer application on total uptake of Cu and Mn at different stages of crop growth (kg ha^{-1})

Treatments	Copper				Manganese			
	Knee high	Tasseling	Harvest		Knee high	Tasseling	Harvest	
			Straw	Grain			Straw	Grain
T_1	0.011	0.054	0.107	0.058	0.084	0.472	0.993	0.278
T_2	0.012	0.062	0.119	0.061	0.091	0.502	1.023	0.281
T_3	0.013	0.069	0.123	0.068	0.094	0.602	1.07	0.326
T_4	0.016	0.093	0.16	0.074	0.117	0.756	1.204	0.358
T_5	0.015	0.087	0.148	0.079	0.114	0.685	1.166	0.367
T_6	0.017	0.098	0.177	0.083	0.127	0.790	1.278	0.381
SEd	0.0003	0.003	0.01	0.001	0.002	0.013	0.025	0.002
CD (0.05)	0.0006	0.007	0.023	0.002	0.004	0.029	0.053	0.004

T1 – Farmers' practice (Basal application of 50kg Urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T2 – Farmers' practice with micronutrient mixture @ 15 kg ha^{-1} as EFYM
T3 - RDF
T4 – CF1- RDF with TNAU micronutrient mixture @ 15 kg ha^{-1} for hybrid as enriched farm yard manure
T5 – CF2- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as straight chemical fertilizer
T6– CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} for hybrid as enriched farm yard manure

was ranged from 0.029 to 0.045 kg ha^{-1} kg ha^{-1} at knee high stage, 0.153 to 0.289 kg ha^{-1} at tasseling stage and at harvest stage, the uptake for straw and grain ranged between 0.301 and 0.465 kg ha^{-1}, 0.093 and 0.147 kg ha^{-1} respectively. Copper uptake was ranged from 0.011 to 0.017 kg ha^{-1} at knee high stage, 0.054 to 0.098 kg ha^{-1} at tasseling stage and at harvest stage, the uptake for straw and grain ranged between 0.107 and 0.177 kg ha^{-1}, 0.058 to 0.083 kg ha^{-1} respectively. Manganese uptake was ranged from 0.084 to 0.127 kg ha^{-1} at knee high stage, 0.472 to 0.790 kg ha^{-1} at tasseling stage and at harvest stage, the uptake for straw and grain ranged between 0.993 and 1.278 kg ha^{-1}, 0.278 to 0.381 kg ha^{-1} respectively. Irrespective of the stages, the application of RDF with micronutrient mixture (TNAU formulation) @ 30 kg ha^{-1} as EFYM (T_6) recorded the highest micronutrient uptake. The improved the micronutrients uptake in maize might be due to the increased micronutrients availability, by the release of organically bound micronutrients through the formation of chelates thereby minimizing the adsorption and fixation of micronutrients in soil (Asad and Rafique, 2000) (Patel *et al.,* 2008). This was followed by the application of TNAU micronutrient mixture @ 15 kg ha^{-1} as EFYM (T_4). The least nutrient uptake was recorded in the farmers' practice for all the stages (T_1).

From this study, it is clearly evident that the customized fertilizer application for maize to maximize the yield of crop with sustainable soil fertility. The application of CF3- RDF with TNAU micronutrient mixture @ 30 kg ha^{-1} as EFYM (T_6) proved better by registering 32 per cent higher yield than farmers' practice. It could be concluded that the recommended dose of fertilizers with TNAU micronutrient mixture as EFYM @ 30 kg ha^{-1} may be recommended for maize to maximise the yield with higher net profit.

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