International Journal of Agriculture, Environment and Biotechnology
Citation: *IJAEB*: **14**(04): 505-509, December 2021
DOI: 10.30954/0974-1712.04.2021.4

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

HORTICULTURE

Customized Fertilizers for Enhancing Yield and Quality of Bitter Gourd

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Paper No. 938 **Received:** 02-09-2021 **Revised:** 28-11-2021 **Accepted:** 06-12-2021

ABSTRACT

Customized fertilizers are ready to apply multinutrient fertilizers to meet the specific nutritional requirement of a crop. Customized fertilizer with major nutrients alone and with micronutrients were prepared and evaluated on the growth, yield and quality of bitter gourd. Two field experiments were conducted at Horticultural College and Research Institute, Periyakulam, Tamil Nadu, India. The results revealed that application of 100% CFII (T_7) found to record the highest the vine length, primary branches/vine, number of fruits/vine, fruit length, fruit yield per plant and fruit yield. Quality parameters of the fruits also revealed that ascorbic acid, TSS, Fe and Zn content were significantly higher in the treatment receiving application of 100% CFII with micronutrients. The results indicated that customized fertilizers with major and micronutrients through fertigation results in better growth, fruit yield and quality in bitter gourd.

HIGHLIGHTS

- Application of 100% CFII (T7) found to record the highest the vine length, primary branches/vine, number of fruits/vine, fruit length, fruit yield per plant and fruit yield.
- Quality parameters of the fruits were significantly higher in the treatment receiving application of 100% CFII with micronutrients.

Keywords: Bitter gourd, customized fertilizers, yield and quality

Fertilizer is one of the key inputs in augmenting food grain production and it contribute towards 55 per cent of additional food grain production (Kaleeswari *et al*. 2013). The scope for extending the cultivable area is limited and hence enhancing the productivity in unit area is the only option and fertilizer is the main cart puller (Choudhary *et al*. 2020). Imbalanced application of fertilizers is a common problem across the country. The All India Coordinated Research Project on Micronutrients by the ICAR has shown widespread micronutrient deficiencies in India. A study revealed a wide variation in the concentrations of available S and micronutrients in agricultural soils of India with per cent deficiency of available S (58.6%), available Zn (51.2%), available B (44.7%), available Fe (19.2%), available Cu (1104%) and available Mn (17.4%) (Shukla *et al*. 2021).

The customized fertilizers may be of the combination of nutrients based on soil testing and requirement of a crop and the formulation may contain primary, secondary and micro nutrients. The FCO recognizes customized fertilizers importance and defined as: Multi-nutrient carriers designed to contain macro, secondary and/or micronutrient both from inorganic

How to cite this article: Sellamuthu, K.M., Janaki, D., Kaleeswari, R. and Malathi, P. 2021. Customized Fertilizers for Enhancing Yield and Quality of Bitter Gourd. *Int. J. Ag. Env. Biotech.*, **14**(04): 505-509.

Source of Support: None; **Conflict of Interest:** None

sources and/or organic sources, manufactured through a systematic process of granulation, satisfying the crop's nutritional needs, specific to its site, soil and stage validated by a scientific crop model, capability developed by an accredited fertilizer manufacturing/marketing company (Rakshit *et al*. 2012). Customized fertilizer is a Tailor made multi- nutrient carrier to meet specific basal nutritional needs of a crop (Majumdar and Prakash 2018). Application of customized fertilizers promotes site specific nutrient management to achieve maximum use efficiency of applied nutrients with cost effectiveness (Kamble and Kathmale 2015). In India, there are about 36 customized formulations approved by fertilizer control order (Majumdar and Prakash 2018). Hence, customized fertilizers can help in improving the formulation for site specific, balanced fertilizer management strategies and also will be more advantageous compared to conventional, blanket and imbalanced fertilizer recommendation (Prakash *et al.* 2021).

MATERIALS AND METHODS

First field experiment was conducted during September 2019 – January 2020 with variety Co-1 bitter gourd and the second field experiment with Palee Hybrid during Rabi 2020 in the Western Block, Horticultural College and Research Institute, Periyakulam, Tamil Nadu, India to study yield and qualityas influenced by graded levels of customized fertilizers. Initial soil samples were collected analyzed pH, EC, organic carbon, available, N, P and K, Ca, Mg, S and micronutrients viz., DTPA- Fe, Zn, Mn, Cu and HWS-boron. The treatments were imposed as per the treatment schedule. Sowing was done with bitter gourd hybrid Palee and observations on biometrics, yield and its quality parameters were recorded.

The treatments include, T_1 – Untreated control, T_2 – Humic Acid(62.5 l ha^{-1}), T_3 – 75% CF I, T_4 – 100% CF I, T_5 – 125 % CF I, T_6 –75 % CF II, T_7 – 100% CF II, T_8 – 125% CF II and T_9 – 100% RDF (as 19:19:19). Customized fertilizer were prepared on N equivalent basis to match the recommended dose of fertilizers for bitter gourd.CF- I consist of only macronutrients while CF- II contains macro and micronutrients. Recommended dose of fertilizer (RDF) for bitter gourd in Tamil Nadu is 200:100:100 kg N:P_2O_5: $K_2O$$ha^{-1}$. Four splits of RDF as customized fertilizers was applied as per the recommended fertigation schedule. The fertilizers were applied through fertigation. The observations like length of vine, primary branches/vine, number of fruits/vine, fruit length, girth,fruit weight/vine,

Table 1: Initial soil properties of experimental site

Particulars	Expt. I	Expt. II	Method	Reference
pH	7.42	7.65	Potentiometry	Jackson (1973)
EC (dS m^{-1})	0.12	0.03	Conductometry	Jackson (1973)
Organic carbon (g kg^{-1})	0.27	0.25	Chromic acid wet digestion method	Walkley and Black (1934)
Nitrogen (kg ha^{-1})	210	266	Extracted with $KMnO_4$ and distilled	Subbiah and Asija (1956)
Phosphorus (kg ha^{-1})	18.5	21.0	Olsen's extraction method, Spectrophotometry	Jackson (1973)
Potassium(kg ha^{-1}	125	220	NH_4OAc extractant method, Flame photometry	Stanford and English (1949)
Calcium (mg kg^{-1})	540	640	NH_4OAc extractant method, Flame photometry	Jackson (1973)
Magnesium (mg kg^{-1})	260	336	NH_4OAc extractant method, Flame photometry	Jackson (1973)
Sulphur (mg kg^{-1})	14.8	15.8	$CaCl_2$ extractant method, Turbidimetry	Williams and Steinbergs (1959)
Iron (mg kg^{-1})	2.4	2.55	DTPA extraction method, Atomic Absorption spectrophotometry	Lindsay and Norvel (1978)
Zinc (mg kg^{-1})	0.38	1.31	DTPA extraction method, Atomic Absorption spectrophotometry	Lindsay and Norvel (1978)
Manganese (mg kg^{-1})	5.24	3.35	DTPA extraction method, Atomic Absorption spectrophotometry	Lindsay and Norvel (1978)
Copper (mg kg^{-1})	1.52	1.21	DTPA extraction method, Atomic Absorption spectrophotometry	Lindsay and Norvel (1978)
Boron (mg kg^{-1})	1.60	1.69	Hot water extraction	Berger and Troug (1944)

fruit yield, Brix and ascorbic acid, Fe and Zn content in fruits were recorded. Brix and ascorbic acid were estimated as per AOAC (2007). Plant samples were drawn, cleaned, dried at 70° C and powdered using Wiley mill and analysed for total Fe and Zn content (Jackson, 1973) and determined in AAS (Lindsay and Norvel, 1978).

RESULTS AND DISCUSSION

Yield parameters

The observations on vine length, number of primary branches, vine length number of fruits per vine, fruit length and fruit girth were recorded. The results from the first experiment revealed that application of 100% CFII (T_7) found to record the highest the vine length(m) of 5.78 m, primary branches/ vine (9.60), number of fruits/vine (28.50), fruit length of 37.0 cm and girth of 9.90cm followed by T_8,T_4,T_5 and T_6 while the untreated control (T_1) recorded the lowest values in all these characters (Table 2 and 3).

In the second field experiment, application of 100% CFII (T_8) found to record the highest vine length (m) of 5.04 m while 100% CFII (T_7) recorded the highest no of primary branches/ vine (9.00) highest number of fruits/vine (27.6), fruit length (35.7cm) and girth (9.71cm) while the untreated control (T_1) recorded the lowest value of in all these characters (Table 2 and 3).

Mean data from the two field experiments indicated that length of vine varied from 3.11 to 5.32 m and the highest vine length was recorded in the treatment receiving application of 100% CFII (T_7). Number of primary branches ranged from 4.97 per plant in control to 9.30 per plant in 100% CFII (T_7). Number of fruits per plant varied from 15.44 to 28.03 and the highest was in 100% CFII (T_7). Mean fruit length varied from 24.8 to 36.4 cm, fruit girth from 6.29 to 9.80 cm and single fruit weight from 89.1 to 130.3 g. The highest value for fruit length, fruit girth and single fruit weight was recorded with the application of 100% CFII (T_7) (Table 2 and 3).

Table 2: Effect of customized fertilizers on length of vine, number of primary branches and fruits per plant

Treatment	Length of vine (m)			Number of primary branches / plant			Number of fruits/ plant		
	Expt. I	Expt. II	Pooled Mean	Expt. I	Expt. II	Pooled Mean	Expt. I	Expt. II	Pooled Mean
T1	3.54	2.68	3.11	6.50	3.44	4.97	18.0	12.9	15.44
T2	3.85	2.95	3.40	7.00	5.22	6.11	22.0	16.8	19.39
T3	4.32	3.53	3.93	7.70	6.44	7.07	23.0	20.6	21.78
T4	4.56	4.05	4.30	8.10	7.67	7.88	26.0	24.2	25.11
T5	4.39	4.25	4.32	7.90	7.22	7.56	24.5	23.8	24.14
T6	4.48	4.53	4.51	9.10	7.00	8.05	27.8	24.2	26.01
T7	5.78	4.87	5.32	9.60	9.00	9.30	28.5	27.6	28.03
T8	5.52	5.04	5.28	9.40	8.89	9.14	27.6	27.1	27.36
T9	4.28	3.72	4.00	8.00	6.78	7.39	20.0	21.9	20.94
SEd	0.24	0.06		0.14	0.26		0.48	0.35	
CD	0.51	0.12		0.30	0.54		1.04	0.74	

Table 3: Effect of customized fertilizers on fruit length, fruit girth single fruit weight

Treatment	Fruit length (cm)			Fruit girth (cm)			Single fruit weight (g)		
	Expt. I	Expt. II	Pooled Mean	Expt. I	Expt. II	Pooled Mean	Expt. I	Expt. II	Pooled Mean
T1	26.1	23.5	24.8	7.00	5.59	6.29	72.2	106.1	89.1
T2	28.5	30.0	29.2	7.80	7.28	7.54	81.8	113.7	97.7
T3	29.5	31.0	30.3	7.90	8.12	8.01	95.7	132.8	114.2
T4	32.8	34.0	33.4	8.50	9.09	8.80	92.3	140.7	116.5
T5	32.5	33.4	32.9	8.20	9.02	8.61	114.3	139.0	126.6
T6	35.2	33.0	34.1	9.20	8.93	9.07	107.9	139.6	123.7
T7	37.0	35.7	36.4	9.90	9.71	9.80	112.3	148.4	130.3
T8	36.4	35.6	36.0	9.60	9.66	9.63	112.3	145.8	129.0
T9	27.2	32.1	29.6	7.30	8.53	7.92	100.0	134.7	117.3
SEd	0.53	0.68		0.13	0.32		0.49	2.78	
CD	1.15	1.44		0.28	0.69		1.04	5.90	

Combined application of NPK and micronutrients as customized fertilizer might have increased the yield parameters by enhancing the use efficiency of major nutrients by the micronutrients. This was evident from Bharati *et al*. (2018). To enhance the productivity of bitter gourd, balanced use of macro as well as micronutrients together with better management practices for the improvement in the availability of nutrients are highly essential.

YIELD AND QUALITY PARAMETERS

Fruit yield

Results on fruit yield from the field experiment-I revealed that application of 100% CFII (T_7) found to record the highest the fruit weight/vine (3.2kg) and fruit yield (24.60 t ha^{-1}). Similarly in the second experiment, application of 100% CFII (T_7) found to record the highest fruit weight/vine (3.20 kg) and fruit yield (24.60 t ha^{-1}). Mean fruit yield per plant varied from 2.31 to 5.57 kg per plant and the highest was recorded in 100 % CF II (T_7). Mean fruit yield ranged from 12.3 to 25.7 t ha^{-1} and the highest was recorded in the treatment receiving application of 100% CFII (T_7) (Table 4).

Micronutrients are important for growth, yield, fruit setting, post-harvest life of crops and resistance development against stresses. But now in Indian soils, along with the single nutrient deficiency, deficiencies of two or more nutrients were prevalent in different states of India (Shukla *et al*. 2021). Hence, combining micronutrient along with the primary and secondary nutrients are essential to get higher yield and better fruit quality. Enhancement of yield of bitter gourd with micronutrients was observed by Ashraf *et al*. (2020).

Fruit Quality

In the experiment-I, the highest values of Ascorbic acid (120.30 mg/100g), TSS(4.88^0 Brix), Fe (432 ppm) and Zn (78 ppm) were recorded in the treatment receiving application of 100% CFII (T_7) and it was followed by T_8 while the untreated control (T_1) recorded the lowest level of Ascorbic acid content (98.50 mg/100g), TSS (3.54^0 Brix), Fe (311ppm) and Zn (40 ppm) (Table 4). Quality parameters from the experiment-II also revealed that Ascorbic acid (111.4 mg/100g), TSS (4.97^0 Brix), Fe (334 ppm) and Zn (78 ppm) were significantly higher in the treatment receiving application of 100% CFII (T_7) followed by T_8 while the untreated control (T_1) recorded the lowest value of Ascorbic acid (83.1 mg/100g), TSS (2.93^0 Brix), Fe (298 ppm) and Zn (47.8 ppm) in all these characters (Table 5).

Mean data of the two experiments indicated that Ascorbic acid, TSS, Fe and Zn content varied from 90.8 to 115.8 mg/100g, 3.24 to 4.92 O' brix, 305 to 382 ppm and 43.9 to 68.6 ppm respectively. Application of major and micro nutrients as customized formulation found to enhance the quality parameters of bitter gourd. Kamble and Kathmale (2015) observed that customised fertilizers improved the yield and quality parameters of onion. Ashraf *et al*. (2020) also found that combination of micronutrients gave good results regarding quality attributes of bitter gourd.

Table 4: Effect of customized fertilizers on fruit yield per plant and fruit yield

Treatment	Fruit yield per plant (kg)			Fruit yield (t ha^{-1})		
	Expt. I	Expt. II	Pooled Mean	Expt. I	Expt. II	Pooled Mean
T1	1.30	3.32	2.31	13.5	11.1	12.3
T2	1.80	4.88	3.34	15.5	16.3	15.9
T3	2.20	5.78	3.99	17.5	19.3	18.4
T4	2.40	6.84	4.62	19.5	22.8	21.1
T5	2.80	6.75	4.78	20.3	22.5	21.4
T6	3.00	7.16	5.08	21.5	23.9	22.7
T7	3.20	8.06	5.63	24.6	26.9	25.7
T8	3.10	8.04	5.57	22.4	26.8	24.6
T9	2.00	6.17	4.08	18.5	20.6	19.5
SEd	0.09	0.13		0.45	0.43	
CD	0.18	0.27		0.97	0.91	

Table 5: Effect of customized fertilizers on fruit quality of bitter gourd

Treatment	Ascorbic acid content in fruit (mg/100g)			TSS content in fruit (O′ brix)			Fe content in fruit (ppm)			Zn content in fruit (ppm)		
	Expt. I	Expt. II	Pooled Mean	Expt. I	Expt. II	Pooled Mean	Expt. I	Expt. II	Pooled Mean	Expt. I	Expt. II	Pooled Mean
T1	98.5	83.1	90.8	3.54	2.93	3.24	311	298	305	40.0	47.8	43.9
T2	103.4	93.8	98.6	3.62	3.20	3.41	321	304	313	45.0	52.4	48.7
T3	108.5	98.1	103.3	4.02	4.17	4.09	342	316	329	52.0	54.4	53.2
T4	112.3	104.0	108.2	4.32	4.63	4.48	356	324	340	65.0	56.2	60.6
T5	113.1	102.4	107.8	4.40	4.40	4.40	382	326	354	66.0	56.4	61.2
T6	116.1	104.3	110.2	4.52	4.53	4.53	410	326	368	72.0	57.6	64.8
T7	120.3	111.4	115.8	4.88	4.97	4.92	432	332	382	78.0	59.2	68.6
T8	118.3	110.1	114.2	4.68	4.77	4.72	422	334	378	74.0	59.8	66.9
T9	110.5	100.0	105.3	4.22	4.27	4.24	356	324	340	65.0	56.4	60.7
SEd	0.92	1.25		0.06	0.14		5.7	1.42		1.74	0.26	
CD	1.97	2.66		0.13	0.29		12.3	3.01		3.73	0.55	

CONCLUSION

The results from the two field experiments revealed that application of 100% CFII (T_7) found to record the highest the vine length, primary branches/ vine, number of fruits/vine, fruit length, fruit yield per plant, fruit yield. Quality parameters also revealed that ascorbic acid, TSS, Fe and Zn content were significantly higher in the treatment receiving application of 100% CFII (T_7). The results revealed that application customized fertilizers as major and micronutrients through fertigation results in higher growth, fruit yield and quality parameters of bitter gourd.

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