Supporting Information for

Metal citrate nanoparticles: A robust water soluble plant micronutrient source

K.S.V. Poorna Chandrika[a,b], Dinabandhu Patra[a], Praduman Yadav[b], Md. A. Aziz Qureshi[b], and Balaji Gopalan[a*]

[b]Crop Production Section, ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad, Telangana 500030, India.

[a]Department of Chemistry, Birla Institute of Technology and Science (BITS) Pilani, Hyderabad Campus, Jawahar Nagar, Kapra Mandal, Hyderabad, 500078, India.

*Corresponding author: E-mail addresses: gbalaji@hyderabad.bits-pilani.ac.in

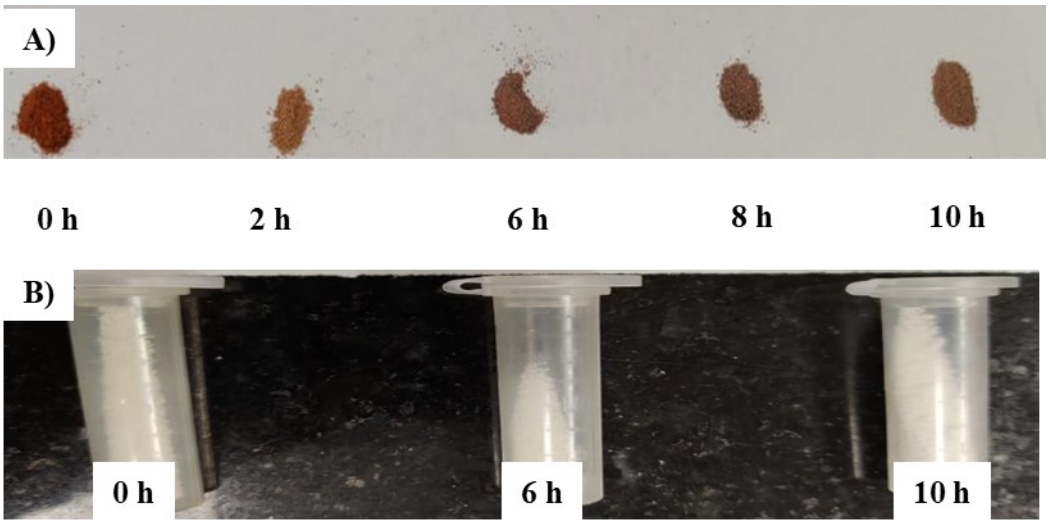


Fig. S1: Different durations of ball milled samples of A) ferric citrate and B) zinc citrate

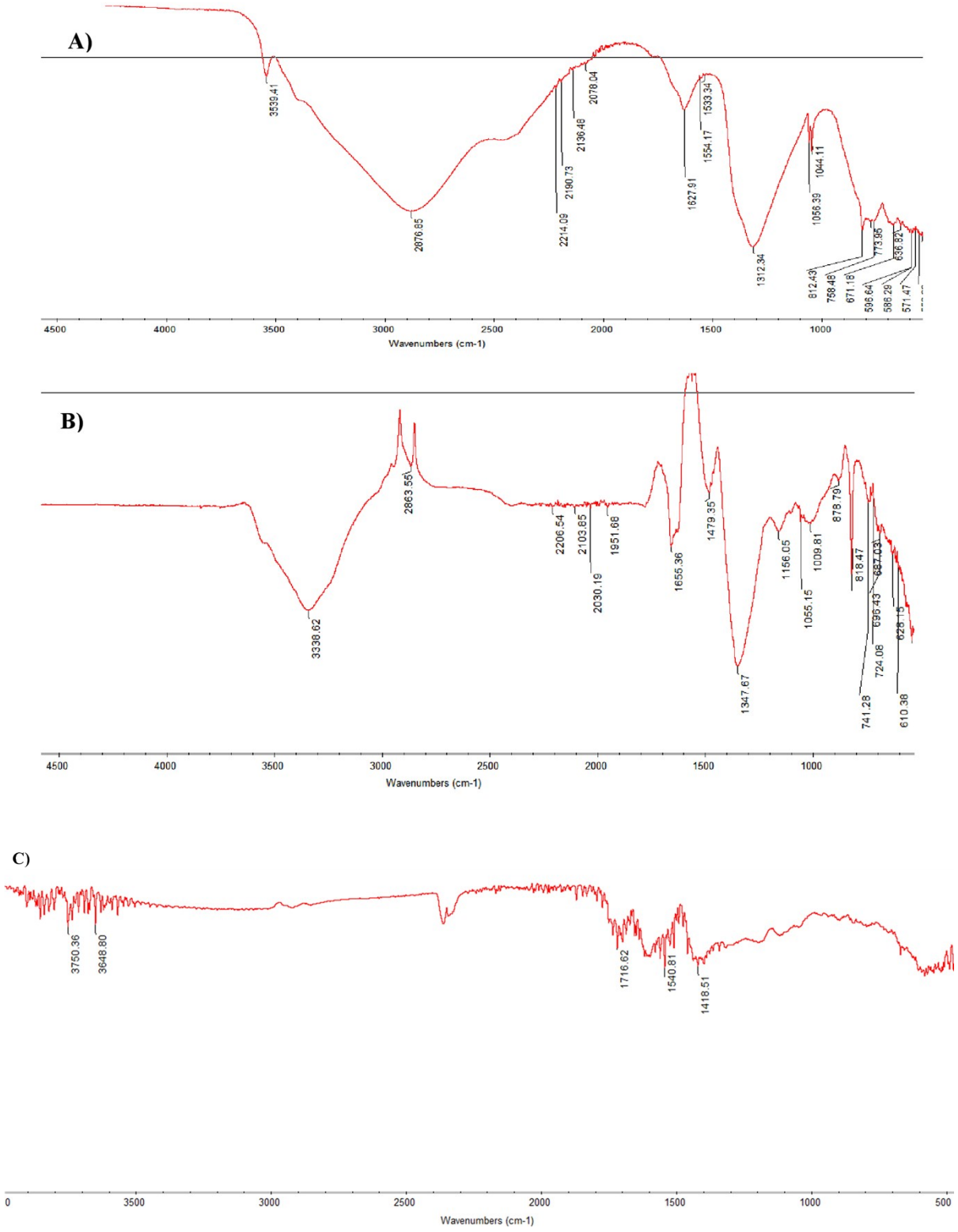
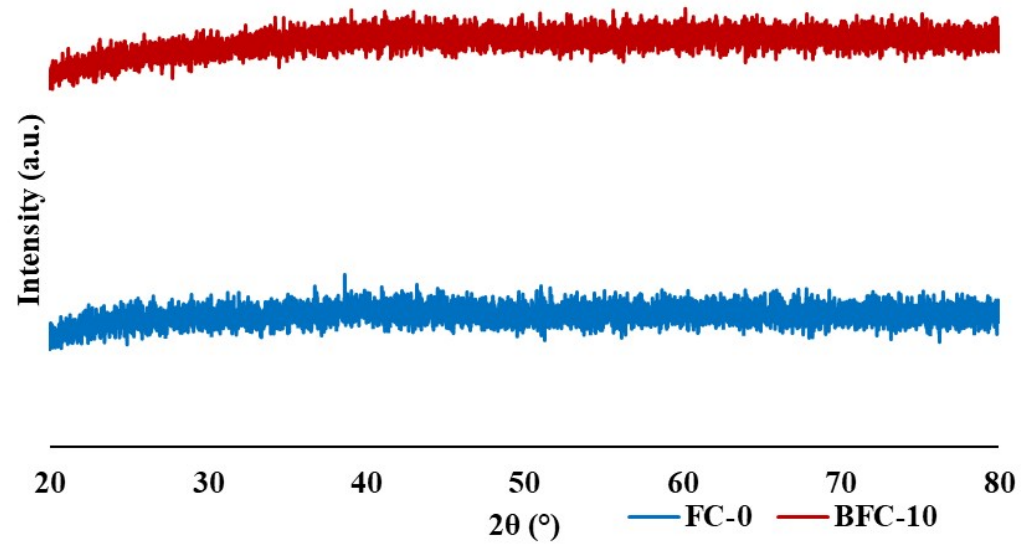
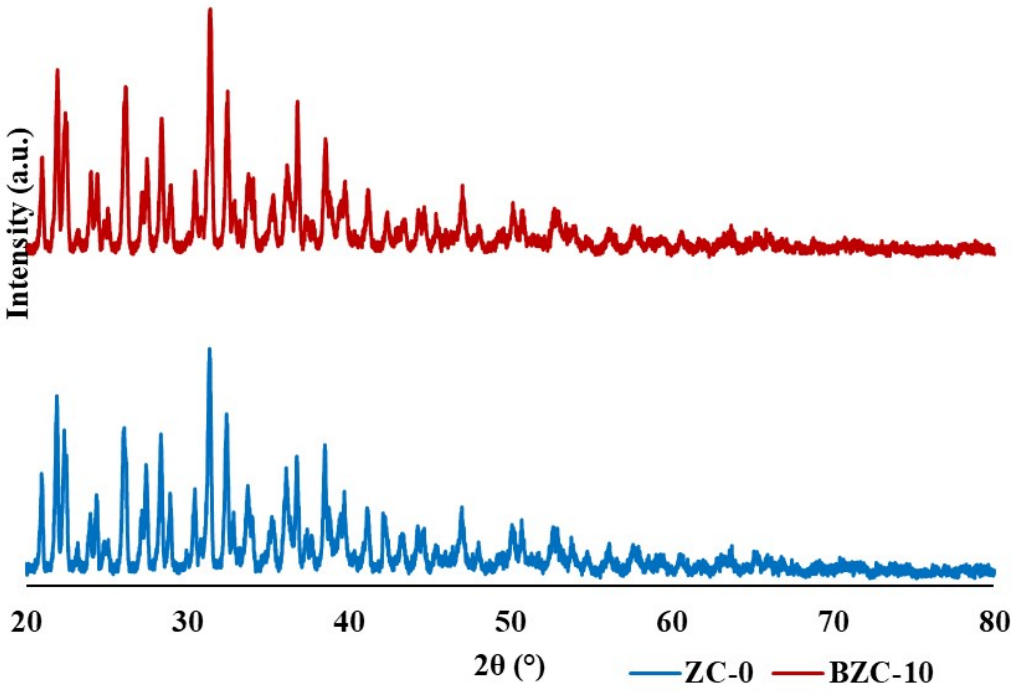


Fig S2: FTIR spectra of A) Ferric nitrate B) Zinc nitrate and C) FC-0 washed with solvent

A)


Intensity (a.u.)
20
30
40
50
60
70
80
2θ (°)
FC-0
BFC-10

B)


Intensity (a.u.)
20
30
40
50
60
70
80
2θ (°)
ZC-0
BZC-10

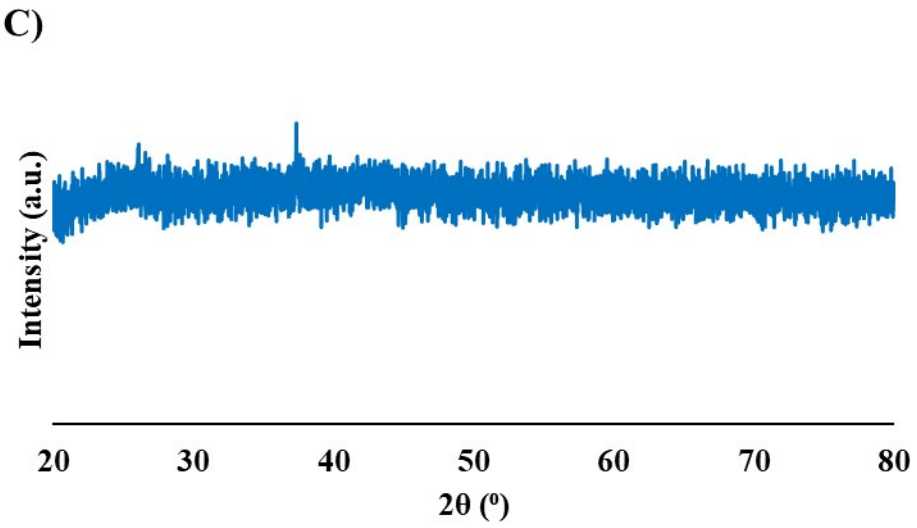


Fig S3: XRD of A) Ferric citrates (FC-0 and BFC-10) B) Zinc citrates (ZC-0 and BZC-10) and C) FC-0 washed with solvent*
*Sample washed with the solvent did not show much change in XRD

Table S1: Estimation of nitrate through Devarda's distillation and citric acid through titration method in citrates

Treatment	Citric acid ()	% NO_3
FC-0 (1:1)	5.4 ml T.V.	0.04389
ZC-0 (1:3)	8.6 ml T.V.	0.00196
FC-0 (1:3)	15.5 ml T.V.	0.0028
ZC-0 (1:1)	1.7 ml T.V.	0.071
FC-0 (1:1) washed with solvent*	2.1 ml T.V.	0.032

*Sample washed with the solvent did not show much change in nitrate

Table S2: Plant uptake studies with ferric citrates in soybean (var. JS-335)

Treatment	Nutrient concentration of Fe µg/ g of dry weight	Plant uptake of Fe µg/ g of dry weight
Control	100	-
Ferric nitrate nonahydrate	165.8	65.8
Zinc nitrate hexahydrate	181.1	81.1
FC 1:3 0 h	364.4	264.4
FC 1:1 with added 2 moles equivalent citric acid 0 h	410.7	310.7

Commercial available FC 0hours	358.1	258.1
FC-0 (1:1) washed with solvent	287	187

*Sample washed with the solvent did not show much difference in nutrient uptake

Table S3: Plant uptake studies with various types of nanoparticles in soybean of previous literature

S.No	Nutrient form	Concentration of nutrient studied	No. of days exposed	Uptake by plant (Zn/ Fe)
1)	ZnO NPs [S1]	500 mg/ L	65% of control roots were 5 mm long	229 mg Zn /kg Dry Weight
		1000, 2000, and 4000 mg /L		135 to 150 mg Zn /kg DW
		Control (0 mg /L)		40 mg Zn /kg DW
2)	ZnO NPs [S2]	Control	48 days	188.4 mg/ kg
		5 g/ kg		252.74 mg/ kg DW
		10 g/ kg		340 mg/ kg DW
		50 g/ kg		710.02 mg /kg DW
3)	ZnO NPs [S3]	Control	65 days	201 mg/ kg DW
		50 mg/ kg		1568 mg/ kg DW
		500 mg/ kg		9463 mg/ kg DW
4)	Iron-Humic Nanofertilizers	35-150 µmol/ pot	48 days	32.6 to 57.8 mg/ kg DW
	FeEDDHA [S4]	50 µmol/ pot		46.7 mg/ kg DW
5)	Fe chelates [S5]	Control	60 days	0.55 µmol
		5 µM		0.36 to 0.68 µmol in fruit

Supplementary References:

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