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Response of nutrient management approaches in conjugation with zinc and iron on growth, yield and yield attributes of foxtail millet (*Setaria italica* L.) chickpea (*Cicer arietinum* L.) cropping sequence

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Abstract
Field experiments were conducted during *kharif* and *rabi* seasons of 2017-18 and 2018-19 at Krishi Vigyana Kendra Farm, University of Agricultural Sciences, Raichur, Karnataka to study the response of nutrient management approaches in conjugation with zinc and iron on growth, yield and yield attributes of foxtail millet-chickpea cropping sequence by involving individual treatments RDF, STL method and SSNM targeted yield approaches and also in combination with different levels of zinc sulphate and iron sulphate. Application of nutrients through SSNM for targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 20 kg ha^{-1} recorded significantly higher plant height (142.19 cm), number of leaves (11.66 $plant^{-1}$), total dry matter production (28.94 g $plant^{-1}$), ear head length (19.88 cm), ear head weight (9.74 g) and grain yield (20.30 q ha^{-1}). The growth parameters of chickpea crop *viz*., plant height, total number of branches $plant^{-1}$ and total dry matter production $plant^{-1}$ (37.38 cm, 35.32 and 19.27 g, respectively), yield attributes *viz.*, number of pods, seed weight and seed yield were significantly higher (47.82 $plant^{-1}$, 18.40 g $plant^{-1}$, 25.06 q ha^{-1} and 23.81 g, respectively) with the residual effect of nutrients applied through SSNM approach for targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 20 kg ha^{-1} followed by SSNM approach for targeted yield of 20 q ha^{-1} $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 10 kg ha^{-1} as compared to other treatments.

Keywords: Foxtail millet-chickpea, cropping sequence, SSNM, targeted yield approaches, growth, yield and yield attributes

Introduction
Foxtail millet and chickpea are the most important crops grown in Karnataka. The productivity of these crops is low as compared with state and national averages, showing potential for yield improvements. Productivity is low as a result of imbalanced usage of major nutrients and under-fertilization without assessing the available nutrient status of soils for the various varieties and hybrids grown. The productivity of foxtail millet-chickpea is largely dependent on its nutrient management. There is significant opportunity for maximizing these crops yield and quality by adopting sustainable nutrient management approach based on soil test results along with application of deficient micronutrients for enhance its grains with Zn and Fe nutrition. Among the various methods of fertilizer applications, the one based on 'yield targeting' (SSNM) is unique in the sense that this method not only indicates soil test based fertilizer dose but also the level of yield the farmer can hope to achieve if good agronomic practices are followed in raising the crop. This approach provides a scientific basis for balanced fertilization not only among the fertilizer nutrient themselves but also soil available nutrients. SSNM demonstrated a potential to increase crop yields and farmer's profits. There is also increasing evidence of the environmental-friendliness of SSNM as it focused on balanced and crop need-based nutrient application. The study on sustainable nutrient management approach based on the soil test results in STL method and SSNM under field situation is more essential for maximizing the growth, yield and yield attributes by maintaining the nutrient balance.

Generally black soils are deficient in Zn and Fe due to its low solubility in soils is the major reason for appearance of deficiency in crop plants. Breeding of new genotypes having high Zn and Fe concentration (genetic bio fortification) is the most cost-effective strategy to address the problem; but this strategy needs long time. Soil application of zinc and iron make sure success of breeding efforts for increasing their concentration in seeds and it is a rapid solution to the problem. Studies on fertilizer focusing specifically on increasing Zn and Fe levels of grain along with different nutrient management approaches are very rare.

Material and Methods

The present investigation was undertaken to study the "Response of nutrient management approaches in conjugation with zinc and iron on growth, yield and yield attributes of foxtail millet (*Setaria italica* L.)-chickpea (*Cicer arietinum* L.) cropping sequence" during *kharif* and *rabi* seasons of 2017-18 and 2018-19, conducted at Krishi Vigyana Kendra Farm, University of Agricultural Sciences, Raichur. The soil was medium black and silty clay in texture, alkaline in reaction (pH 8.08), low in organic carbon (4.30 g kg^{-1}) and available nitrogen (245.20 kg ha^{-1}), medium in P_2O_5 (38.67 kg ha^{-1}), high in available potassium (336.53 kg ha^{-1}), deficient in zinc (0.52 mg kg^{-1}) and iron (3.45 mg kg^{-1}). The experiment was repeated on the same site for two years. The experiment was laid out in Randomized Complete Block Design (RCBD) and replicated thrice. The treatment includes targeted yield of foxtail millet through SSNM along with absolute control, recommended dose of fertilizers (30: 15: 15 kg N: P_2O_5: K_2O ha^{-1}), STL method (37.5: 15: 11.25, N, P_2O_5 and K_2O kg ha^{-1}). The quantity of fertilizer for SSNM treatments was calculated using the formulae (Website: http:// www.ipni.net, 2010) [15]. The average removal of N, P_2O_5 and K_2O from the soil to produce one tonne of foxtail millet grain was 19.75, 17.5 and 30.2 kg ha^{-1}, respectively (Upendra *et al.*, 2017) [14]. Accordingly, N, P_2O_5 and K_2O required were calculated by multiplying targeted yield with nutrient removal. After calculating, the soil nutrient ratings (low & high) are considered for recommendation of fertilizers @ $\pm$ 30 per cent. Accordingly, the quantity of N, P_2O_5 and K_2O for 1.5 and 2.0 t ha^{-1} were 38.52: 26.25: 31.71 and 51.35: 35: 42.28 N, P_2O_5, K_2O kg ha^{-1}, respectively. All the treatments are applied individually and in combination with $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 10 & 20 kg ha^{-1}.

Foxtail millet (HMT 100-1) was sown on 1st Aug and 18th July and harvested on 11th November and 26th October during 2017-18 and 2018-19, respectively. Basal dose of fertilizers (50 % N and 100 % P, K, Zn and Fe) in the form of urea, diammonium phosphate (DAP), muriate of potash (MOP), $ZnSO_47H_2O$ and $FeSO_47H_2O$ were applied as per treatments at 4-5 cm deep and 5 cm away from the seed as basal dose. Remaining half dose of nitrogen was top dressed at 30 days after sowing (DAS). The required amount of FYM @ 6.5 t ha^{-1} was applied for all treatments uniformly for main crop (except T_1) during both the years of experimentation. The residual effects of foxtail millet crop treatments were studied using chickpea crop in the same plot during 2017-18 and 2018-19. After harvest of foxtail millet, chickpea (JG 11) was sown on 24th and 8th November and harvested on 27th and 8th February during first and second year, respectively. The growth, yield and yield attributes of both the crops were recorded at harvest.

Results and Discussion

The crop growth, yield and yield attributes of both foxtail millet and chickpea crops were slightly better in the second season crop (2018-19) than first season crop (2017-18) and it might be due to better crop establishment and congenial weather conditions during crop growth. However, the pattern of response was similar in both the years and hence only pooled data of two years are discussed in this paper.

Growth attributes of foxtail millet: Pooled results showed that, application of nutrients through SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} showed taller plant height and more number of leaves over absolute control, RDF and STL method (Table 1). The plant height also contributed for total dry matter was significantly higher in application of nutrients through SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} (142.19 cm) followed by SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 10 kg ha^{-1} (138.63 cm) at harvest. The results show that application of nutrients through SSNM along with zinc and iron significantly enhanced the plant height over control during both the years of experimentation as well as on pooled analysis and may be due to the application of balanced dose of nutrients Similar findings has been reported by Choudhary *et al.* (2017) [3] in sorghum.

The significantly higher number of leaves per plant was observed with SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} (11.66) followed by SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 10 kg ha^{-1} (11.25) at harvest and this could be due to balanced application of nutrients in chickpea (Mahantesh *et al.*, 2013) [6] and pearl millet crop (Sharanappa, 2017) [11].

The total dry matter produced in foxtail millet plant was higher in SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} (28.94 g $plant^{-1}$ at harvest) which was on par with SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 10 kg ha^{-1} (27.83 g $plant^{-1}$) and SSNM approach targeted yield of 15 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} (27.66 g $plant^{-1}$) and these are significantly higher as compared to control, RDF, STL method. The increased dry matter was usually associated with taller plant height and more number of leaves per plant which led to greater accumulation of photosynthesis. Similar results were reported by Dashadi *et al.* (2013) [4] in lentil crop and Shreenivas *et al.* (2017) [12] in maize crop. Similar results indicating increased dry matter production due to increased levels of N, P, K, Zn & Fe was reported by Arya and Singh (2000) [1] in maize crop.

Table 1: Effect of nutrient management approaches in conjugation with zinc and iron on growth parameters of foxtail millet

Treatments	Plant height (cm)			Number of leaves $plant^{-1}$			Total dry matter production (g $plant^{-1}$)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1	93.95	94.89	94.42	7.33	7.42	7.37	19.18	19.36	19.27
T_2	102.30	109.15	105.73	8.40	9.73	9.07	20.49	21.71	21.10
T_3	104.93	112.87	108.90	8.47	9.87	9.17	21.16	22.45	21.81
T_4	109.17	115.72	112.44	8.57	9.93	9.25	21.92	23.35	22.63

T_5	115.07	123.04	119.06	8.60	10.00	9.30	22.18	23.66	22.92
T_6	121.47	130.55	126.01	8.87	10.07	9.47	23.48	24.85	24.17
T_7	124.80	132.29	128.54	9.27	10.40	9.83	24.23	25.86	25.04
T_8	127.10	136.24	131.67	9.40	10.87	10.13	25.24	26.76	26.00
T_9	134.20	143.05	138.63	10.26	12.24	11.25	26.97	28.69	27.83
T_{10}	122.30	131.35	126.83	8.93	10.27	9.60	23.52	25.10	24.31
T_{11}	125.87	133.81	129.84	9.33	10.73	10.03	24.48	25.91	25.19
T_{12}	131.80	140.88	136.34	9.99	11.20	10.59	26.88	28.45	27.66
T_{13}	137.67	146.72	142.19	10.65	12.66	11.66	28.06	29.83	28.94
S. Em. ±	3.24	3.45	3.56	0.40	0.50	0.48	0.75	0.77	0.73
C.D. at 5 %	9.58	10.20	10.39	1.20	1.47	1.38	2.19	2.24	2.18

Note: 1) RDF (30:15:15 kg ha^{-1}. NPK)
2) FYM @ 6.5 t ha^{-1} was applied for all treatments except T_1

T_1:	Absolute control (No NPK & FYM)	T_8:	T_4 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}
T_2:	RDF	T_9:	T_5 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}
T_3:	STL method	T_{10}:	T_2 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_4:	SSNM approach (Targeted yield: 15 q ha^{-1})	T_{11}:	T_3 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_5:	SSNM approach (Targeted yield: 20 q ha^{-1})	T_{12}:	T_4 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_6:	T_2 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}	T_{13}:	T_5 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_7:	T_3 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}		

Yield and yield attributes of foxtail millet: Pooled results registered significantly higher yield and yield attributes with the nutrient application through targeted yield approach in combination with $ZnSO_47H_2O$ and $FeSO_47H_2O$. The significantly higher grain (20.30 q ha^{-1}) and stover yield (36.34 q ha^{-1}) (Table 2) were recorded in treatment receiving SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} over absolute control (10.21 and 29.26 q ha^{-1}), RDF (14.66 and 30.32 q ha^{-1}), STL method (14.87 and 30.92 q ha^{-1}), SSNM approach targeted yield 15 q ha^{-1} (16.29 and 31.28 q ha^{-1}), SSNM approach targeted yield of 20 q ha^{-1} (17.25 and 31.65 q ha^{-1}), T_2 + $ZnSO_47H_2O$ + $FeSO_47H_2O$ each @ 10 kg ha^{-1} (17.29 and 32.09 q ha^{-1}), T_3 + $ZnSO_47H_2O$ + $FeSO_47H_2O$ each @ 10 kg ha^{-1} (17.47 and 32.94 q ha^{-1}), T_4 + $ZnSO_47H_2O$ + $FeSO_47H_2O$ each @ 10 kg ha^{-1} (18.93 and 34.56 q ha^{-1}), T_2 + $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 20 kg ha^{-1} (17.41 and 32.18 q ha^{-1}) and T_3 + $ZnSO_47H_2O$ + $FeSO_47H_2O$ each @ 20 kg ha^{-1} (17.72 and 33.76 q ha^{-1}). Abundant supply of nutrients through zinc and iron along with FYM and SSNM might have increased foxtail millet yield. The results of the investigation are in line with Ashoka *et al*. (2008) [2] in maize-chickpea sequence cropping. The higher grain and stover yields of foxtail millet were also due to better translocation of photosynthate from source to sink and higher growth attributing characters like higher number of leaves and dry matter production and its accumulation into different parts of plant and yield attributing characters like, ear head length, ear head weight, thousand seed weight. The studies are also agreement with the findings of Shreenivas *et al*. (2017) [12] that pooled results registered significantly higher grain yield of maize (8.62 t ha^{-1}) with treatment receiving SSNM approach targeted yield of 8.0 t ha^{-1}. Mandal *et al.* (2009) [7] reported that SSNM based nutrient management recorded significantly higher grain yield and straw yield of cowpea which may be due to better nutrient availability during the crop growth period.

The ear head length and weight differed significantly due to application of nutrients through SSNM targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 20 kg ha^{-1} (19.88 cm and 9.74 g, respectively) as compared to all other treatments and it was on par with SSNM targeted yield of 20 t ha^{-1} $ZnSO_47H_2O$ + $FeSO_47H_2O$ each @ 10 kg ha^{-1} (19.43 cm and 8.53 g, respectively) and T_4 + $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 20 kg ha^{-1} (18.63 cm and 8.97g , respectively) . The results showed that length of ear head and weight increased directly by the increased dose of major nutrients on SSNM basis in combination with Zn and Fe +FYM. Meena *et al*. (2018) [8] reported that the combined application of NPK as RDF +7.5 kg Zn +10 kg Fe ha^{-1} and FYM 10 t ha^{-1} increased length of ear head of pearl millet by 45.2 per cent over control. This result also conformity with findings of Navya Jyothi *et al*. (2016) [9] in foxtail millet and Singh *et al*. (2017) [13] in pearl millet. Higher ear head weight was noticed due to adequate supply of primary nutrients especially K in combination of Zn and Fe + FYM were responsible for the translocation of food materials in plants therefore it played a vital role in grain setting as well as higher number of grains per ear head there by treatment T_{13} increased ear head weight by 2.21, 8.58 and 80.37 per cent (Table 2) over T_9, T_{12} and control, respectively.

Table 2: Effect of nutrient management approaches in conjugation with zinc and iron on yield and yield attributes of foxtail millet

Treatments	**Ear head length (cm)**			**Ear head weight (g)**			**Grain yield (q ha^{-1})**		
	2017-18	**2018-19**	**Pooled**	**2017-18**	**2018-19**	**Pooled**	**2017-18**	**2018-19**	**Pooled**
T_1	12.55	13.06	12.81	5.08	5.72	5.40	10.03	10.38	10.21
T_2	13.18	17.13	15.16	6.54	7.68	7.11	14.51	14.81	14.66
T_3	13.70	17.63	15.67	6.85	8.08	7.47	14.71	15.02	14.87
T_4	14.36	18.13	16.24	7.03	8.19	7.61	16.07	16.51	16.29
T_5	14.85	18.51	16.68	7.68	8.44	8.06	17.03	17.47	17.25
T_6	15.10	19.11	17.10	7.79	8.53	8.16	17.06	17.52	17.29
T_7	15.75	19.73	17.74	7.92	8.95	8.43	17.20	17.73	17.47
T_8	16.21	20.17	18.19	8.56	9.18	8.87	18.65	19.20	18.93
T_9	17.58	21.28	19.43	9.23	9.83	9.53	19.97	20.47	20.22
T_{10}	15.40	19.30	17.35	7.84	8.75	8.30	17.12	17.69	17.41
T_{11}	15.88	20.08	17.98	8.12	9.03	8.57	17.46	17.98	17.72

T_{12}	17.02	20.25	18.63	8.65	9.28	8.97	18.88	19.42	19.15
T_{13}	18.13	21.63	19.88	9.32	10.15	9.74	20.06	20.54	20.30
S. Em.±	0.38	0.47	0.43	0.24	0.31	0.29	0.45	0.39	0.42
C.D. at 5 %	1.12	1.39	1.28	0.71	0.91	0.86	1.34	1.16	1.24

Note: 1) RDF (30:15:15 kg ha^{-1}. NPK)
2) FYM @ 6.5 t ha^{-1} was applied for all treatments except T_1

T_1:	Absolute control (No NPK & FYM)	T_8:	T_4 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}
T_2:	RDF	T_9:	T_5 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}
T_3:	STL method	T_{10}:	T_2 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_4:	SSNM approach (Targeted yield: 15 q ha^{-1})	T_{11}:	T_3 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_5:	SSNM approach (Targeted yield: 20 q ha^{-1})	T_{12}:	T_4 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_6:	T_2 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}	T_{13}:	T_5 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_7:	T_3 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}		

Growth parameters of chickpea: The significantly higher plant height, number of branches and total dry matter production respectively were observed in residual effect of nutrients through SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ each @ 20 kg ha^{-1} (37.38 cm, 35.32 and 19.27 g $plant^{-1}$, respectively) (Table 3) followed by SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 10 kg ha^{-1} (36.96 cm, 35.05 and 19.14 g $plant^{-1}$), SSNM approach targeted yield of 15 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} (36.05 cm, 34.33 and 18.90 g $plant^{-1}$) and SSNM approach targeted yield of 15 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 10 kg ha^{-1} (34.92 cm, 34.07 and 18.42g $plant^{-1}$), respectively. Increase in plant height, number of branches and total dry matter production may be attributed due to greater availability of residual nutrients in soil after harvest of foxtail millet. Greater availability of Zn and Fe enhanced the plant growth through increased photosynthesis and other physiological activities and also helped the plants to better utilize the available nutrients with increased leaf area, high photosynthesis and dry matter accumulation which enhanced crop growth rate. Similar results also reported by Shreenivas *et al*. (2017) [12] in chickpea that significantly higher plant height, number of branches and total dry matter production were observed in residual effect of nutrients through SSNM approach targeted yield of 8.0 t ha^{-1} (36.55 cm, 29.57 and 19.13 g $plant^{-1}$). Patil *et al.* (2018) [10] reported that the application of fertilizers based on SSNM for targeted yield of 2.5 t ha^{-1} + S + B + Zn produced maximum (31.82 g $plant^{-1}$) total dry matter accumulation in ground nut, which were significantly superior over recommended dose of fertilizers (22.00 g $plant^{-1}$).

Table 3: Residual effect of nutrient management approaches in conjugation with zinc and iron on growth parameters of chickpea

Treatments	Plant height (cm)			Total number of branches $plant^{-1}$			Total dry matter production (g $plant^{-1}$)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1	28.62	32.09	30.35	27.72	28.82	28.27	13.12	13.85	13.49
T_2	29.24	32.70	30.97	29.47	30.06	29.77	15.37	16.09	15.73
T_3	29.59	33.08	31.33	30.04	30.94	30.49	15.84	16.64	16.24
T_4	29.91	33.45	31.68	29.97	31.34	30.66	16.21	16.89	16.55
T_5	30.43	34.01	32.22	31.19	31.78	31.49	16.48	17.15	16.82
T_6	30.47	34.07	32.27	31.36	32.39	31.88	16.56	17.25	16.90
T_7	31.11	34.83	32.97	32.61	33.29	32.95	17.45	18.13	17.79
T_8	33.24	36.59	34.92	33.54	34.60	34.07	18.05	18.80	18.42
T_9	35.03	38.89	36.96	34.48	35.55	35.02	18.88	19.40	19.14
T_{10}	30.53	34.08	32.30	32.19	32.92	32.56	17.18	17.98	17.58
T_{11}	31.81	35.60	33.70	32.95	33.57	33.26	17.73	18.66	18.20
T_{12}	34.18	37.91	36.05	33.80	34.86	34.33	18.46	19.33	18.90
T_{13}	35.51	39.24	37.38	34.78	35.86	35.32	18.91	19.62	19.27
S. Em. ±	0.81	0.92	0.86	0.60	0.43	0.62	0.39	0.36	0.37
C.D. at 5 %	2.36	2.69	2.52	1.78	1.27	1.83	1.15	1.05	1.08

Note: 1) RDF (30:15:15 kg ha^{-1}. NPK)
2) FYM @ 6.5 t ha^{-1} was applied for all treatments except T_1

T_1:	Absolute control (No NPK & FYM)	T_8:	T_4 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}
T_2:	RDF	T_9:	T_5 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}
T_3:	STL method	T_{10}:	T_2 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_4:	SSNM approach (Targeted yield: 15 q ha^{-1})	T_{11}:	T_3 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_5:	SSNM approach (Targeted yield: 20 q ha^{-1})	T_{12}:	T_4 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_6:	T_2 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}	T_{13}:	T_5 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_7:	T_3 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}		

Yield and yield attributes of chickpea: The pooled results showed significantly higher number of pods $plant^{-1}$, seed weight $plant^{-1}$ and grain yield (47.82, 18.40 g and 25.06 q ha^{-1}) of chickpea (Table 4) due to residual effect of nutrient through SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} over all other treatments and it was found on par with SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 10 kg ha^{-1} (47.59, 18.19 g and 24.82 q ha^{-1}), SSNM approach targeted yield of 15 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} (47.23, 17.78 g and 24.65 q ha^{-1}) and SSNM approach targeted yield of 15 q ha^{-1} + $ZnSO_47H_2O$ and

$FeSO_47H_2O$ @ 10 kg ha^{-1} (47.09, 17.38 g and 24.28 q ha^{-1}).The better performance of succeeding chickpea could be due to higher amount of available nitrogen, phosphorous, potassium, zinc and iron after harvest of foxtail millet. Foxtail millet cultivar HMT100-1 being relatively less duration one and it requires small quantity of nutrients for its entire crop growth period, removed lower amount of nutrient from soil and made substantial build up in soil as reflected higher soil nutrient status after harvest of foxtail millet. Meena *et al*. (2018) [8] studied that the residual effect of combined application of 5 kg Zn +10 kg Fe +10 t FYM to proceeding crop pearl millet resulted in significantly higher grain and straw yield of mustard. Similar results were obtained by Gawai *et al*. (2005) [5] studied that the residual effect of application of 100 per cent RDF and 5 t FYM ha^{-1} to proceeding crop sorghum resulted in significantly higher grain and haulm yield of chickpea. The similar interpretation was also reported by Shreenivas *et al*. (2017) [12] that the better performance of succeeding chickpea could be due to higher amount of available nitrogen, phosphorus and potassium after harvest of maize.

In conclusion application of nutrients through SSNM approach targeted yield of 20 q ha^{-1} + $ZnSO_47H_2O$ and $FeSO_47H_2O$ @ 20 kg ha^{-1} (51.35: 35: 42.28: 20: 20, kg N, P_2O_5, K_2O, $ZnSO_47H_2O$ and $FeSO_47H_2O$ ha^{-1}, respectively) was superior in foxtail millet-chickpea sequence to produce higher growth, yield attributes and productivity.

Table 4: Residual effect of nutrient management approaches in conjugation with zinc and iron on yield and yield attributes of chickpea

Treatments	Number of pods $plant^{-1}$			Seed weight (g $plant^{-1}$)			Grain yield (q ha^{-1})		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1	35.43	35.51	35.47	13.09	13.61	13.35	13.65	12.91	13.28
T_2	43.36	43.92	43.64	14.67	14.78	14.73	21.24	20.88	21.06
T_3	43.85	45.72	44.79	14.99	14.92	14.96	21.67	20.90	21.29
T_4	44.04	46.19	45.12	15.57	15.81	15.69	22.21	21.83	22.02
T_5	45.24	48.31	46.78	16.04	16.37	16.21	22.69	23.49	23.09
T_6	45.03	48.06	46.55	16.15	16.30	16.23	22.95	23.45	23.20
T_7	45.26	48.38	46.82	16.67	16.97	16.82	23.38	23.68	23.53
T_8	45.53	48.65	47.09	17.31	17.45	17.38	23.94	24.61	24.28
T_9	46.06	49.12	47.59	18.08	18.30	18.19	24.40	25.23	24.82
T_{10}	45.15	48.26	46.71	16.37	16.63	16.50	23.18	23.30	23.24
T_{11}	45.38	48.42	46.90	16.88	17.09	16.99	23.68	24.22	23.95
T_{12}	45.62	48.84	47.23	17.69	17.87	17.78	24.12	25.18	24.65
T_{13}	46.25	49.39	47.82	18.26	18.54	18.40	24.64	25.48	25.06
S. Em.±	0.29	0.33	0.31	0.50	0.52	0.51	0.28	0.33	0.32
C.D. at 5 %	0.85	0.96	0.91	1.47	1.55	1.52	0.81	0.96	0.93

Note: 1) RDF (30:15:15 kg ha^{-1}. NPK)
2) FYM @ 6.5 t ha^{-1} was applied for all treatments except T_1

T_1:	Absolute control (No NPK & FYM)	T_8:	T_4 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}
T_2:	RDF	T_9:	T_5 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}
T_3:	STL method	T_{10}:	T_2 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_4:	SSNM approach (Targeted yield : 15 q ha^{-1})	T_{11}:	T_3 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_5:	SSNM approach (Targeted yield : 20 q ha^{-1})	T_{12}:	T_4 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_6:	T_2 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}	T_{13}:	T_5 + $ZnSO_47H_2O$ @ 20 kg ha^{-1} + $FeSO_47H_2O$ @ 20 kg ha^{-1}
T_7:	T_3 + $ZnSO_47H_2O$ @ 10 kg ha^{-1} + $FeSO_47H_2O$ @ 10 kg ha^{-1}		

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