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Response of soil test based nutrient management approaches on growth and yield of soybean in soybean- sorghum based cropping system

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Abstract
An experiment was conducted during *kharif* and *rabi* seasons of 2017-18 and 2019-20 at Agricultural Research Station, Janwada farm, Bidar district, to identify the suitable nutrient management approaches for enhancing production potentials of soybean-sorghum cropping system. The experiment consisted of thirteen treatments with application of different category of nutrients as per soil test based nutrient management approaches including absolute control and RDF. Significantly higher seed (54.73 q ha^{-1}) and haulm (68.38 q ha^{-1}) yield of soybean was recorded in SSNM approach targeted yield of 30 q ha^{-1} + 25 kg $FeSO_4$ $5H_2O$ ha^{-1} (T_{13}) and the increase was to an extent of 65.81 and 36.54 Percent, respectively when compared to absolute control. The increase in seed and haulm yield of soybean in T_{13} could be due to the maximum plant height (cm), leaves plant^{-1}, branches plant^{-1}, total dry matter production (g plant^{-1}) and nodules plant^{-1} of soybean as influenced by nutrient management approaches in conjugation with iron at different growth stages.

Keywords: Soybean, targeted yield approach, soil test, growth and yield

Introduction
Soybean (*Glycine max* L.) is considered as a natural fertilizer factory because of its high nitrogen fixing property with rhizobium. Being a leguminous crop, it is expected to improve soil fertility and productivity of succeeding crop. The crop in fact has revolutionized the agricultural economy with its immense potential for food, seed and industrial products. Soybean like most legumes performs nitrogen fixation by establishing symbiotic relationship with bacteria, *Rhizobium japonicum*. In India, the annual soybean production was 10.98 million tonnes with its area under cultivation was 10.47 million hectares and average productivity is 1049 kg ha^{-1} (2017-18) Fourth advance estimates, Directorate of Economics and Statistics, (New Delhi). Madhya Pradesh is known as the soybean bowl of India, contributing 59 Percent of the national soybean production, followed by Maharashtra (29 Percent and Rajasthan (6 Percent) contribution. Andhra Pradesh, Karnataka, Chhattisgarh and other parts of India also produce the soybean in small quantities (Anon, 2013). In Karnataka, soybean is grown over an area of 0.32 million hectares with production of 2.91 million tonnes and productivity of 991 kg ha^{-1} in 2018-19 according to Soybean Processors Associations of India. Among the various approaches of fertilizer application, the one based on 'yield targeting' (Site specific nutrient management, Soil test crop response and Soil test laboratory method) are unique in the sense that these methods not only consider soil test-based fertilizer dose but also indicates the level of yield the farmer can hope to achieve if good agronomic practices are followed in raising the crop. For a given soil plant system located in a climatic belt, these approaches are unique because it provides a scientific basis for balanced fertilization not only among the fertilizer nutrient themselves but also soil available nutrients. Thus, there is an urgent need for more site-specific nutrient recommendations that can be readily transferred and can meet farmer's production goals and resources. The soil test based nutrient management approaches do not significantly aim to either reduce or increase fertilizer use. Instead, it aims to timely application of nutrients at optimal rates in order to achieve higher yields and higher nutrient use efficiency by the crops.

Material and Methods

The field experiment was conducted during *kharif* and *rabi* seasons of 2017-18 and 2018-19 at Agricultural Research Station, Janwada, Bidar district, which comes under the jurisdiction of University of Agricultural Sciences, Raichur. It is situated between 17.91^0 North latitude and 77.51^0 East longitudes at an altitude of 615 m above the Mean Sea Level and is located in the North Eastern transitional zone of Karnataka. Bidar district receives well distributed rainfall from both South-West and North-East monsoons. The normal annual rainfall of Bidar is 884 mm of which majority rainfall is received during the months of June to October with highest in August. The maximum and minimum temperature ranges from 39.8°C in the month of April to 12.1°C in the month of January, the relative humidity of 90 Percent in the month of December to 42 Percent in the month of April. The soil of the experimental site is clay in texture (Sand 18.90%, silt 23.43% and clay 56.67%), with a bulk density of 1.16 Mg m^{-3}, particle density of 2.92 Mg m^{-3} and having maximum water holding capacity 58.25 Percent. The soil pH is 7.69 with electrical conductivity of 0.31 dS m^{-1}. The soil is low in organic carbon content (0.43 g kg^{-1}), available nitrogen (210.0 kg ha^{-1}) and medium in available phosphorus (24.0 kg ha^{-1}) and high in available potassium (340 kg ha^{-1}). While other parameters *viz.*, sulphur (10.70 mg kg^{-1}), exchangeable calcium and magnesium (35.40 and 24.7 C mol (p^+) kg^{-1}) are within the normal ranges that are comparable to any normal soils of this region. However, this experimental soil is low in available boron (0.47 mg kg^{-1}), zinc (0.56 mg kg^{-1}), iron (2.70 mg kg^{-1}) and high in copper and manganese were 1.18 and 30.5 mg kg^{-1} respectively. Soybean JS 335 used as a crop variety. The experiment was laid out in RCBD included thirteen treatments consisted of T_1: Absolute control (00: 00: 00 NPK kg ha^{-1}), T_2: RDF- (40:80:25 kg ha^{-1}. NPK +30 kg ha^{-1} S +12.5 kg ha^{-1} $ZnSO_47H_2O$ + 1.0 kg ha^{-1} boron), T_3: STL- (Soil testing laboratory method), T_4: STCR approach (Targeted yield 25 q ha^{-1}), T_5: STCR approach (Targeted yield 30 q ha^{-1}), T_6: SSNM approach (Targeted yield 25 q ha^{-1}), T_7: SSNM approach (Targeted yield 30 q ha^{-1}), T_8: RDF- Recommended Dose Fertilizer + 25 kg ha^{-1} $FeSO_4$ $5H_2O$, T_9: STL- Soil Testing Laboratory method + 25 kg ha^{-1} $FeSO_4$ $5H_2O$, T_{10}: STCR approach (Targeted yield 25 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4$ $5H_2O$, T_{11}: STCR approach (Targeted yield 30 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4$ $5H_2O$, T_{12}: SSNM approach (Targeted yield 25 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4$ $5H_2O$, T_{13}: SSNM approach (Targeted yield 30 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4$ $5H_2O$ and FYM @ 2.4 t ha^{-1} was applied for all treatments except absolute control. The recommended dose of fertilizer for soybean in the North-Eastern transitional zone of Karnataka (Zone-1) is 40: 80: 25 kg N: P_2O_5: K_2O ha^{-1} + 30 kg ha^{-1} S +12.5 kg ha^{-1} $ZnSO_47H_2O$ + 1.0 kg ha^{-1} boron (Package of practice, UAS Raichur, 2016). Nitrogen, phosphorus, potassium, zinc, iron and boron in the form of Urea, Diammonium phosphate (DAP), Muriate of potash (MOP), gypsum, zinc sulphate, Ferrous sulphate and borax, respectively were applied. As per RDF, full dose of N, P, K, Zn and boron were applied at basal. Sulphur applied as source of gypsum 20 days before sowing. Seed /grain yield and haulm/stover yield per hectare were recorded. Five plants were harvested from each treatment at harvest stage. The following growth and yield parameters *viz.* plant height (cm), leaves $plant^{-1}$, branches $plant^{-1}$, total dry matter production (g $plant^{-1}$) and nodules $plant^{-1}$ number of pods, pod weight, hundred seed weight, seed yield, haulm yield and harvest index of soybean as influenced by nutrient management approaches in conjugation with iron at different growth stages was recorded. The response of soybean to soil test based nutrient approaches was similar in both the years of study. Therefore, only pooled data of two years is discussed.

Results and Discussion

Application of nutrients through targeted yield approach exerted significant influence on the growth and yield of soybean. Significantly higher plant height (58.05 cm), leaves $plant^{-1}$(23.34), branches $plant^{-1}$(5.13), total dry matter production (g $plant^{-1}$) (52.33), and nodules $plant^{-1}$ (16.0), number of pods(79.55), pod weight (48.05 g), hundred seed weight(13.75 g), seed yield (2782 kg ha^{-1}), haulm yield (5197 kg ha^{-1}) and harvest index (53.3%) of soybean was recorded with treatment receiving SSNM approach for targeted yield of 30 q ha^{-1} + 25 kg ha^{-1} $FeSO_4$ $5H_2O$ as compared to other treatments. And it was found on par with T_5:STCR approach targeted yield of 30 q ha^{-1}, T_6:SSNM approach targeted yield of 25 q ha^{-1}, T_7:SSNM approach targeted yield of 30 q ha^{-1}, T_{10}: STCR approach targeted yield of 25 q ha^{-1} + 25 kg ha^{-1} $FeSO_4$ $5H_2O$,T_{11}: STCR approach targeted yield of 30 q ha^{-1} + 25 kg ha^{-1} $FeSO_4$ $5H_2O$ and T_{12}: SSNM approach targeted yield of 25 q ha^{-1} + 25 kg ha^{-1} $FeSO_4$ $5H_2O$. However, lowest plant height (30.70 cm), leaves $plant^{-1}$(10.13), branches $plant^{-1}$(2.42), total dry matter production (g $plant^{-1}$) (20.84), and nodules $plant^{-1}$ (6.58), number of pods(39.55), pod weight (20.66 g), hundred seed weight(7.08 g), seed yield (951 kg ha^{-1}), haulm yield (3298 kg ha^{-1}) and harvest index (28.6%) was found in absolute control.

The higher seed yield can be attributed to the ability of targeted yield approaches to satisfy the nutrient demand of crop more efficiently. The higher seed yield of soybean was also due to better translocation of photosynthates from source to sink and higher growth attributing characters like plant height (58.05 cm), leaves $plant^{-1}$(23.34), branches $plant^{-1}$(5.13), total dry matter production (g $plant^{-1}$) (52.33), and nodules $plant^{-1}$ (16.0), number of pods(79.55), pod weight (48.05 g), hundred seed weight(13.75 g), seed yield (2782 kg ha^{-1}), haulm yield (5197 kg ha^{-1}) and harvest index (53.3%) (Table 2 and fig.1, 2 and 3). These results are in accordance with the findings of Ashok *et al*. (2013) who reported that nutrient application through SSNM for targeted yield of 10 t ha^{-1} recorded significantly higher number of leaves per plant in maize. Increased number leaves $plant^{-1}$ could be assigned due to application of FYM, phosphorus, and zinc thereby increase in soil microorganism and also due to better moisture and nutrient availability. Singh *et al*. (2017) [10] also found similar results. The above findings are in close agreement with reports of Shirpurkar *et al*. (2005) [8] in soybean and Dhaliwal *et al.* (2009) [2] in wheat. Shreenivas *et al*. (2017) [9] also concluded that application of nutrients through SSNM showed taller plant height and more number of leaves over absolute control, state recommendation, farmers practice and STL method. The plant height also contributed for total dry matter was significantly higher in application of nutrients through SSNM approach targeted yield of 8.0 t ha^{-1} at harvest of maize. Similarly Dhillon *et al.* (2006) [3] reported higher grain yield (46.0 q ha^{-1}) with the application of fertilizer based on targeted yield (45.0 q ha^{-1}) approach when compared to farmers practice, RDF and soil test-based applications. These results are also coroborated with the findings of Doberman *et al.* (2002) [4], Biradar *et al.* (2006) [1], Keram *et al*. (2012) [5], Umesh *et al*. (2014) and Singh *et al.* (2014) [11]. SSNM approach provides a scientific basis for the balanced fertilization not only among the fertilizer nutrient themselves but also soil available nutrients to achive targed yield (Satyanarayana *et al.* 2011) [7]. Further, seed yield is governed by the factors which have direct or indirect impact. The factors which have direct influence on the seed yield are the yield components *viz.*, number of pods, pod weight, hundred seed weight (Table 2) have an indirect influence on seed yield through the yield components, which intern depends on different growth components *viz.*, plant height leaves plant^{-1}, branches plant^{-1}, total dry matter production (g plant^{-1}) and nodules plant^{-1} (Table 1).All these growth components could have been promoted by more quantity of nutrients made available by the treatment received in SSNM approach for targeted yield of 30 q ha^{-1} + 25 kg ha^{-1} $FeSO_4$ $5H_2O$ and evidenced through higher uptake of nutrients as compared to absolute control, RDF and other soil test based approach.

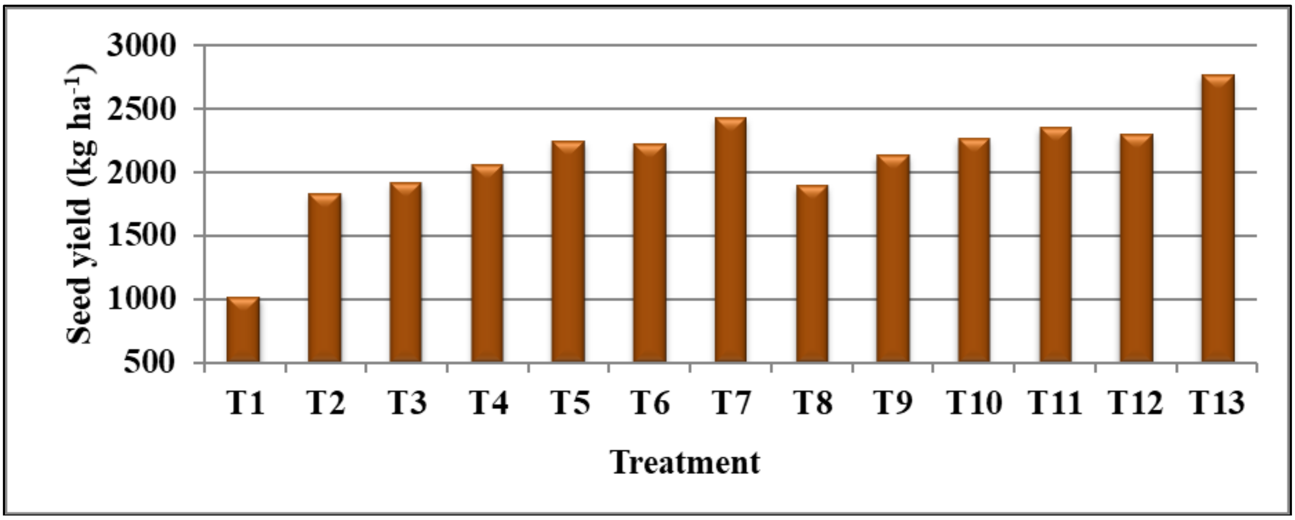

Fig 1: Seed yield of soybean as influenced by different nutrient management approaches in soybean- sorghum based cropping system.

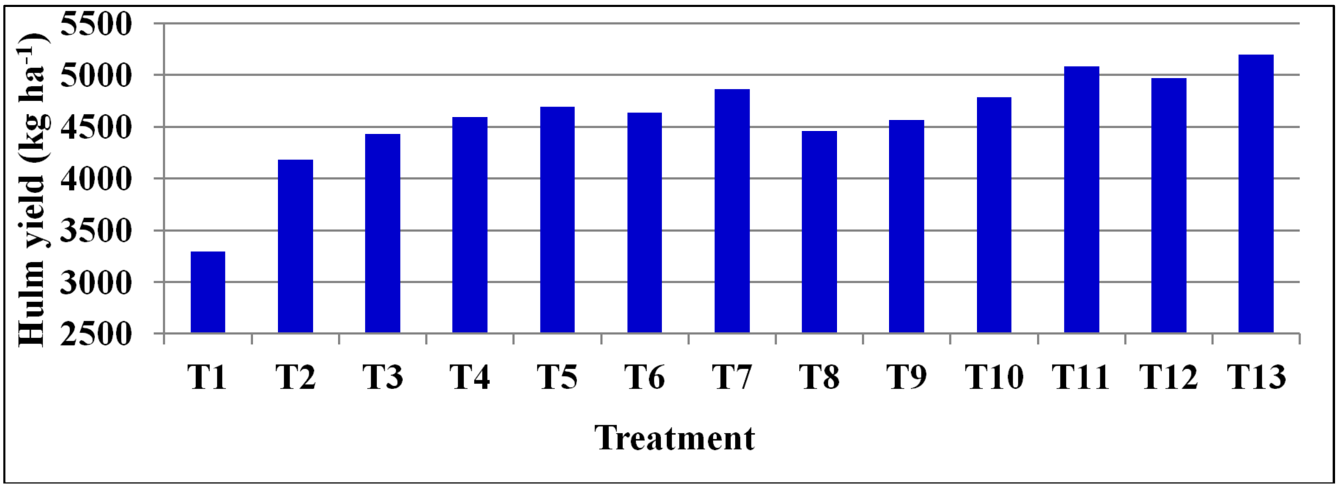

Fig 2: Haulm yield of soybean as influenced by different nutrient management approaches in soybean- sorghum based cropping system.

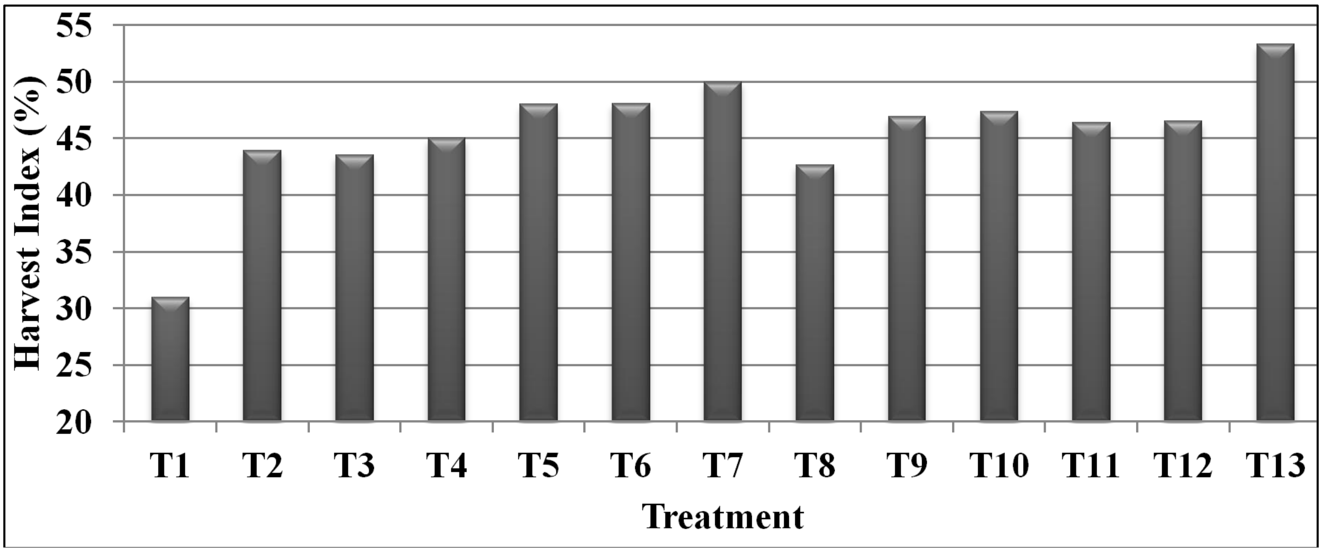

Fig 3: Harvest index of soybean as influenced by different nutrient management approaches in soybean- sorghum based cropping system.

Table 1: Effect of different nutrient management approaches on growth parameters of soybean 2017-18 and 2018-19 (Pooled data of 2 years)

Treatments	Plant height (cm)	Number of leaves plant^{-1}	Number of branches plant^{-1}	Total dry matter production (g plant^{-1})	Number of nodules plant^{-1}
T_1	30.70	10.13	2.42	20.84	6.58
T_2	41.95	16.75	2.89	38.19	11.11
T_3	44.40	17.97	3.19	39.72	11.68
T_4	46.75	18.60	3,25	41.19	12.72
T_5	49.90	19.78	3.50	48.22	13.41
T_6	48.55	19.46	3.37	46.88	13.03
T_7	53.25	20.63	4.72	49.92	14.33
T_8	48.15	17.70	4.07	39.67	11.89
T_9	50.75	18.95	4.35	42.30	12.84
T_{10}	52.80	20.13	4.57	46.33	13.67
T_{11}	56.75	22.50	4.93	50.71	15.10
T_{12}	55.25	21.71	4.79	49.40	14.41
T_{13}	58.05	23.34	5.13	52.33	16.00
S. Em. ±	1.76	0.77	0.22	2.62	0.66
C.D. at 5%	5.13	2.23	0.63	7.63	1.91

Note: 1) RDF (40:80:25 kg ha^{-1}. NPK +30 kg ha^{-1} S +12.5 kg ha^{-1} $ZnSO_4 7H_2O$ + 1.0 kg ha^{-1} boron)
2) FYM @ 2.4 t ha^{-1} was applied for all treatments except absolute control

T_1:	Absolute Control	T_8:	RDF + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_2:	RDF (Recommended Dose of Fertilizer)	T_9:	STL + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_3:	STL- (Soil Testing Laboratory Method)	T_{10}:	STCR approach (Targeted yield of 25 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_4:	STCR approach (Targeted yield of 25 q ha^{-1})	T_{11}:	STCR approach (Targeted yield of 30 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_5:	STCR approach (Targeted yield of 30 q ha^{-1})	T_{12}:	SSNM approach (Targeted yield of 25 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_6:	SSNM approach (Targeted yield of 25 q ha^{-1})	T_{13}:	SSNM approach (Targeted yield of 30 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_7:	SSNM approach (Targeted yield of 30 q ha^{-1})		

Table 2: Effect of different nutrient management approaches on yield parameters of soybean 2017-18 and 2018-19 (Pooled data of 2 years)

Treatments	Number of pods plant^{-1}	Pod weight (g plant^{-1})	100 Seed weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
T_1	39.55	20.66	7.08	951	3298	28.6
T_2	63.05	35.65	10.64	2015	4183	47.8
T_3	65.50	37.75	10.97	2144	4430	47.7
T_4	69.08	42.00	11.45	2150	4592	46.5
T_5	73.45	43.71	12.14	2300	4697	48.7
T_6	71.64	43.18	11.89	2278	4635	48.5
T_7	74.73	46.11	12.84	2534	4868	51.8
T_8	64.62	38.69	11.90	2168	4462	48.0
T_9	68.83	43.25	12.10	2244	4567	48.7
T_{10}	74.08	45.22	12.53	2295	4787	47.8
T_{11}	76.78	47.08	13.51	2397	5083	46.6
T_{12}	75.60	46.05	12.96	2382	4968	47.5
T_{13}	79.55	48.05	13.75	2782	5197	53.3
S. Em. ±	1.87	1.80	0.46	159	138	1.4
C.D. at 5%	5.45	5.22	1.32	465	401	4.0

Note: 1) RDF (40:80:25 kg ha^{-1}. NPK +30 kg ha^{-1} S +12.5 kg ha^{-1} $ZnSO_4 7H_2O$ + 1.0 kg ha^{-1} boron)
2) FYM @ 2.4 t ha^{-1} was applied for all treatments except absolute control

T_1:	**Absolute Control**	T_8:	**RDF + 25 kg ha^{-1} $FeSO_4 5H_2O$**
T_2:	RDF (Recommended Dose of Fertilizer)	T_9:	STL + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_3:	STL- (Soil Testing Laboratory Method)	T_{10}:	STCR approach (Targeted yield of 25 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_4:	STCR approach (Targeted yield of 25 q ha^{-1})	T_{11}:	STCR approach (Targeted yield of 30 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_5:	STCR approach (Targeted yield of 30 q ha^{-1})	T_{12}:	SSNM approach (Targeted yield of 25 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_6:	SSNM approach (Targeted yield of 25 q ha^{-1})	T_{13}:	SSNM approach (Targeted yield of 30 q ha^{-1}) + 25 kg ha^{-1} $FeSO_4 5H_2O$
T_7:	SSNM approach (Targeted yield of 30 q ha^{-1})		

Conclusion

The results obtained in the present investigation which was carried out for two consecutive years (2017-18 and 2018-19) by following different nutrient management approaches on performance of soybean based on the results following conclusions are made. Applications of nutrients based on the soil test results in *viz.*, SSNM approach along with iron under field situation is more useful and profitable due to maximizing productivity and profitability as compared to RDF.

References

1. Biradar DP, Aladakatti YR, Rao TN, Tiwari KN. Site specific nutrient management for maximization of crop yields in Northern Karnataka. Better Crops. 2006; 90(3):33-35.

2. Dhaliwal SS, Sadana US, Khurana MPS, Dhadli HS, Manchanda JS. Bio-fortification of wheat grains with zinc and iron in Typic Ustocherpt soils of Punjab. Indian J Fert. 2009; 5:13-16 and 19-20.
3. Dhillon NS, Vig AC, Brar JS. Soil test-based target yield approach to formulating crop fertilization programme in Punjab. J Res. Punjab Agric. Univ. 2006; 34(4):384-392.
4. Doberman A, Witt C, Dawe D. Performance of site-specific nutrient management in intensive rice cropping systems of Asia. Better Crops Int. 2002; 16(1):25-30.
5. Keram KS, Puri G, Sawarkar SD. Assessment of soil test-based fertilizer recommendation under rice-wheat cropping sequence and its impact on soil quality under agroclimatic condition of Kymore plateau zone of Madhya Pradesh, India. JNKVV Res. J 2012; 46(1):62-68.
6. Police Patil AS. Yield maximization in aerobic rice through site specific nutrient management approach. Ph. D. Thesis, Univ. Agric. Sci., Bangalore, 2011.
7. Satyanarayana T, majumdar K, Biradar DP. New approaches and tools for site-specific nutrient management with reference to potassium. Karnataka J. Agric. Sci. 2011; 24(1):86-90.
8. Shirpurkar GN, Kashid NV, Kamble MS, Gavhane VN. Effect of application of different micronutrients on growth attributing characters of soybean (*Glycine max* (L.) Merrill.). Res. Crops. 2005; 6(2):225-228.
9. Shreenivas BV, Ravi MV, Latha HS. Effect of targeted yield approaches on growth, yield, yield attributes and nutrient uptake in maize (*Zea mays* L.)-chickpea (*Cicer arietinum* L.) cropping sequence in UKP command area of Karnataka. Asian J. Soil Sci. 2017; 12(1):143-150.
10. Singh L, Sharma PK, Jajoria M, Deewan P, Verma R. Effect of phosphorus and zinc application on growth and yield attributes of pearl millet (*Pennisetum glaucum* L.) under rainfed condition. J Pharmacogn. Phytochem. 2017; 6(1):388-391.
11. Singh YV, Sharma PK, Meena R. Effect of soil test crop response technology on productivity and economics of rice crop of Varanasi district of Uttar Pradesh. J. Rural & Agric. Res. 2014; 14(1):77-80.