International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133; Print ISSN: 2664-7125; Impact Factor: RJIF 5.28
Received: 07-10-2020; Accepted: 22-10-2020; Published: 11-11-2020
Volume 2; Issue 4; 2020; Page No. 355-357

Effect of nutrient management techniques on soil fertility and yield of french bean (*Phaseolus vulgaris*) under Northern Dry Zone of Karnataka

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Abstract
The field experiment was conducted during the *Kharif season* from 2015-16 to 2017-18 at College of Horticulture, Munirabad (Koppal), University of Horticultural Sciences, Bagalkot, Karnataka to evaluate the different levels of fertilizers application through different approaches in french bean (*Phaseolus vulgaris*) under alfisol soils. Application of 100 per cent fertilizers application based on specific nutrient management (SSNM) approach with target yield of 15 t ha^{-1} recorded significantly higher fresh pod yield (T_3: 15.1 t ha^{-1}) and it was on par with treatment had 100 per cent fertilizers application based on soil test crop response (STCR) approach with target yield of 15 t ha^{-1}. The Soil pH (1:2.5) and electrical conductivity (dSm^{-1}) as influenced by the application of different levels fertilizers through different approaches at harvest of french bean crop were recorded on par among the treatments. Similarly, application of 100 per cent fertilizers based on site specific nutrient management (SSNM) approach with target yield of 15 t/ha (T_3) at harvest showed significantly higher nutrients levels (T_3: 396.7, 57.7 and 572.3 Kg N, P_2O_5 and K_2O ha^{-1}, respectively), it was on par with 100 per cent fertilizers application based on soil test crop response (STCR) approach with target yield of 15 t/ha (T_6). And the same trend of results were observed soil organic carbon at harvest.

Keywords: SSNM, STCR, Fertilizers, French bean, target yield etc.

Introduction
French bean (*Phaseolus vulgaris L.*) is one of the most important leguminous vegetables in the world. It is an export oriented vegetable which is rich in protein, calcium, iron and vitamins (Haque *et al.*, 2002) [4]. It is used as vegetables when pods are immature and tender. Modern agriculture, no doubt, has paved the way for "Green Revolution", but it has been achieved mainly with the application of chemical fertilizers and pesticides to high yielding varieties with the sole objective of maximizing the yield. India has made indiscriminate consumption of fertilizers during the last four decades. However, during the last few years in many parts of the country, the yield potentials of many crops are either stagnating or declining. Moreover, the imbalanced and inadequate use of chemical fertilizers in intensive cropping systems is the main cause for stagnation in productivity, insecurity in food and environmental hazards. These problems became a big challenge to the scientific community and this necessitating for new research agenda.
French bean is one of the most important leguminous vegetable crops. It is cultivated for the tender vegetable, shelled green beans and dry beans (rajmah). It is very rich in protein, vitamins and minerals. French bean is a short duration crop and farmers get more profit in a short period. Among the several soil test based fertilizer application techniques, site specific nutrient management (SSNM) and soil test crop response (STCR) are cost effective and plant need based approaches with specific yield target are more suitble. The SSNM and STCR approaches not only aim to reduce cost on production or increase fertilizer use and also the effective tools for supplying crop nutrients as and when needed to achieve higher yield, besides these they also aims to increase the nutrient use efficiency, leading to more net returns per unit of fertilizer invested (Shankar and Umesh, 2008) [8, 9]. Considering usefulness of STCR, and SSNM tools for nutrients management in french been crop, the experiment was planned with an objective to find out suitable approaches as best decision support system to enhance growth and yield of french been crop and economic returns with optimum fertilizer application rate.

Material and methods
The field experiment was conducted from 2015-16 to 2017-18 at College of Horticulture, Munirabad (Koppal), University of Horticultural Sciences, Bagalkot situated on the latitude 15.31^{0}N, longitude 76.33^{0}E with 529.0 m elevation from MSL belongs to Northern Dry Zone (Zone 3) of Karnataka. The experiment was laid out in RCBD (Randomised Completely Block Design). The soil of the experimental site was red loamy in texture, slightly alkaline pH (7.8) and low in electrical conductivity (1.80 mSm^{-1}). The soil organic carbon content was 0.48 per cent and soil was low in available N (275.0 kg ha-1), medium in available phosphorus (38.0 kg ha^{-1}) and potassium (215.0 kg ha^{-1}). The S-9 (Arka Komal) variety released by an IIHR, Begaluru was used as a test crop. Treatments consisted of RDF (recommended dose of fertilizers) by University, STV (soil test values), SSNM (site

specific nutrient management) and STCR (soil test crop response) approaches for a target yield of 15 t ha^{-1}, with the different doses of fertilizers application as per the treatment details mentioned below.

STCR equation for French been was developed by All India Coordinated research Project (AICRP) on Soil test Crop response (STCR), Bangalore centre and same was used to calculate the fertilizers requirement (Anon., 2011) [1]. The details of equation is mentioned below.

F.N= 7.26078T- 0.27095 STV - 0.9856 OM
F. P_2O_5= 5.93010T- 0.78748 STV - 0.20549 OM
F. K_2O= 9.04765T- 0.73354 STV - 0.29916 OM

Where,
T = Targeted yield 15 t ha^{-1}
FN = Nitrogen supplied through fertilizer (kg ha^{-1})
FP_2O_5 = Phosphorus supplied through fertilizer (kg ha^{-1})
FK_2O = Potassium supplied through fertilizer (kg ha^{-1})
STV = Soil Test Value
OM= Organic matter per cent in soil
FN, FP and FK are the quantity of nitrogen, phosphorous and potassium to be supplied through fertilizers.

To workout SSNM based fertilizers recommendation, the data on quantity of NPK uptake per tonne considered was 9.0, 0.7 and 8.0 kg t^{-1}, respectively based on several years of field studies. Further, the quantity of fertilizers required for a target yield of 15 t ha^{-1} was worked out.

The soil had lower in available nitrogen and medium supply for available phosphorus and potassium. Hence, we applied 12.5 per cent higher nitrogen and recommended dose of phosphorus and potassium in the treatment with application of fertilizers based on STV. At basal, half of nitrogen, entire dose of phosphorus and potassium in the form of urea, di-ammonium phosphate (DAP) and muriate of potash (MOP) were applied as per treatments. Remaining half of recommended dose of nitrogen was applied as top dressed at 45 days after sowing (DAS). Further, hand weeding have been done at 30 and 50 days after sowing to manage weeds and took the necessary plant protection measures during crop growth periods.

All growth and yield components were recorded at different growth stages of the crop and at harvest. Collected the data on number of pods $plant^{-1}$, fresh pod weight (kg $plot^{-1}$), fresh pod yield (t ha^{-1}) at harvest of the crop. Pod yield from net plot area was converted into per hectare basis.

Chemical analysis of soil

Representative soil samples from the experimental plot were drawn from the top 15 cm depth before sowing of the crop. Similarly, the surface soil samples from 0 to 15 cm depth were also collected from each experimental plot at harvest. Soil samples thus collected were air dried under shade, powdered with wooden pastel and mortar and passed through 2 mm sieve and analyzed for pH, electrical conductivity, organic carbon, nitrogen, phosphorus and potassium content.

The pH of the soil was determined Potentiometric method (Piper, 1966) [7]. and electrical conductivity was by Conductometry (Jackson, 1973) [5]. Determination of available nitrogen in soil was determined by alkali potassium permanganate method with the help of kjeldahl distillation unit (Subbiah and Asija, 1956) [11]. Available phosphorus content of soil was estimated by Olsen's extractant and vanadomolybdate colorimetry method (Jackson, 1973) [5]. and the potassium content was determined by neutral normal ammonium acetate (N NH_4OAc) extractant method and with a microprocessor based flame photometer (Systronics-Flamephotometer 128) (Jackson, 1973) [5]. The experimental data were analysed statistically.

Results and discussions

The maximum number of pods $plant^{-1}$ was observed by application of 100 per cent nutrients based on SSNM for a target yield 15 t ha-1 (34.1) and STCR for target yield 15 t ha^{-1} (33.0), while minimum number of pods $plant^{-1}$ was recorded in an application of 50 per cent nutrients based on STCR for target yield 15 t ha^{-1} (22.4). In case of fresh pod weight (g plant-1) showed that the same trends of results at harvest of French bean crop (Table 1).

Table 1: Effect different levels of fertilizers application through different approaches on yield of French bean crop.

	Treatment	Number of pods $plant^{-1}$	Fresh pod weight (kg $plot^{-1}$)	Fresh pod yield (t ha^{-1})
T_1	RDF through (POP-UHSB).	29.1	8.8	12.7
T_2	Application of fertilizers based on STV.	30.0	9.2	13.0
T_3	100 % fertilizers based on SSNM approach with target yield of 15 t/ha.	34.1	10.2	15.1
T_4	75 % fertilizers based on SSNM approach with target yield of 15 t/ha.	27.5	8.3	11.8
T_5	50 % fertilizers based on SSNM approach with target yield of 15 t/ha.	24.5	6.5	9.8
T_6	100 % fertilizers based on STCR approach with target yield of 15 t/ha.	33.0	9.9	14.9
T_7	75 % fertilizers based on STCR approach with target yield of 15 t/ha.	26.1	7.6	10.8
T_8	50 % fertilizers based on STCR approach with target yield of 15 t/ha.	22.4	6.0	9.4
S Em ±		0.7	0.30	0.40
C D (P=0.05)		2.08	0.75	1.10
C V		4.38	5.37	5.35

The higher pod yield of French bean crop was recorded with application of 100 per cent fertilizers based on SSNM for a target yield of 15 t ha^{-1} (T_3:15.1 t ha^{-1}) and based on STCR target yield 15 t ha^{-1} (T_3:14.9 t ha^{-1}). Among other recommendations fertilizers application based on STV (T_2:13.0 t ha^{-1}) and through RDF by University (T_1:12.7 t ha^{-1}) were statistically on par. Significantly lower grain yield was recorded in treatment with an application of 50 per cent fertilizers based on STCR target yield 15 t ha^{-1} (T_8:9.4 t ha^{-1}) (Table 5). As a consequence of higher plant height, number of branches $plant^{-1}$ and number of leaves $planr^{-1}$

helped production of more number of pods plant-1, fresh pod weight (g plant-1) and finally higher pod yield. The increased mineral nutrient availability in these treatments helped in higher source activity that is larger leaf area which might have enhanced supply of photosynthates to growth and development of plant (Jayaprakash *et al.*, 2005) [6]. (Table 1)**.**

Yield attributes *viz.*, number of pods plant^{-1} and fresh pod weight (g plant^{-1}) are significantly higher in application of 100 per cent fertilizers based on SSNM for a target yield of 15 t ha^{-1} and STCR target yield 15 t ha^{-1} and lowest value were in application of 100 per cent fertilizers based on STCR target yield 15 t ha^{-1}. This is because of adequate quantity of nutrients supplied through SSNM and STCR approaches. These results corroborate with the findings of Umesh (2008) [8, 9]. Gosh *et al.* (2004) [3]. showed importance of balanced fertilization for maintaining soil health and sustainable agriculture. Singh *et al.* (2008) [10]. analyzed comparative response to fertilizer application on the basis of SSNM, State recommendations (SR) and farmers general practice (FP) and clearly found that the FP even though contained higher levels of N or P than SSNM gave lower yields thus advocating the superiority of SSNM. The increased yield under SSNM based nutrient application resulted in improvement of economic returns of corn production.

Similarly profitable rice and wheat production under SSNM in Karnataka was reported by Biradar *et al.* (2006) [2]. in comparison with RDF and farmers practice. Umesh *et al.* (2014) [12]. also reported profitability of maize under SSNM based fertilizers application over blanket recommended fertilizers. It is clear from the study that, treatment with the application of 100 per cent fertilizers based on SSNM with target yield of 15 t ha^{-1} (T_3) approaches giving more grass returns and net profit, the B: C ratio recorded was high in treatment with the application of 100 per cent fertilizers based on STCR with target yield of 15 t ha^{-1} (T_6: 4.8:1) for french bean production under protective irrigation in Alfisol soils Karnataka.

The Soil pH and electrical conductivity (EC) as influenced by the application of different levels fertilizers through different approaches at harvest of French bean crop were recorded on par among the treatments (Table 2).

Application of 100 per cent fertilizers based on site specific nutrient management (SSNM) approach with target yield of 15 t/ha (T_3) at harvest showed significantly higher nutrients levels (T_3: 396.7, 57.7 and 572.3 Kg N, P_2O_5 and K_2O ha^{-1}), it was on par with 100 per cent fertilizers application based on soil test crop response (STCR) approach with target yield of 15 t/ha (T_6: 379.3, 55.3 and 559.3 Kg N, P_2O_5 and K_2O ha^{-1}) (Table 2).

And the same trend of results were observed soil organic carbon at harvest. The similar trends of results were observed by Gosh *et al.* (2004) [3]. he showed importance of balanced fertilization for maintaining soil health and sustainable agriculture.

Table 2: Effect different levels of fertilizers application through different approaches on chemical properties of soil at harvest.

Treatment		pH (1:2.5)	EC (dSm^{-1})	OC (%)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
T_1	RDF through (POP-UHSB).	7.42	0.29	0.51	328.0	41.3	422.7
T_2	Application of fertilizers based on STV.	7.30	0.26	0.57	361.7	42.3	428.3
T_3	100 % fertilizers based on SSNM approach with target yield of 15 t/ha.	7.40	0.28	0.61	396.7	57.7	572.3
T_4	75 % fertilizers based on SSNM approach with target yield of 15 t/ha.	7.43	0.28	0.48	311.0	38.3	392.3
T_5	50 % fertilizers based on SSNM approach with target yield of 15 t/ha.	7.63	0.22	0.42	273.7	35.0	353.3
T_6	100 % fertilizers based on STCR approach with target yield of 15 t/ha.	7.40	0.24	0.60	379.3	55.3	559.3
T_7	75 % fertilizers based on STCR approach with target yield of 15 t/ha.	7.48	0.25	0.44	287.3	36.3	373.3
T_8	50 % fertilizers based on STCR approach with target yield of 15 t/ha.	7.57	0.24	0.42	267.3	38.3	399.0
S. Em $\pm$		0.12	0.02	0.02	16.56	1.59	16.96
C. D. (P=0.05)		0.35	0.06	0.07	48.13	4.63	49.29
C. V.		6.07	32.47	17.50	19.08	13.86	14.54

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