



## Research Article

# EFFECT OF NUTRIENT MANAGEMENT TECHNIQUES ON GROWTH, YIELD AND ECONOMICS OF FRENCH BEAN (*Phaseolus vulgaris*) IN ALFISOL SOILS OF KARNATAKA

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**Abstract:** The field experiment was conducted during the *Kharif* season from 2014-15 to 2016-17 for four years 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*) crops under alfisol soils. Treatments consisted the recommended dose of fertilizers (RDF) by University, application of fertilizers based on soil test values (STV) and three different levels viz., 100, 75 and 50 percent of recommended dose of fertilizers application based on specific nutrient management (SSNM) and soil test crop response (STCR) approaches with target yield of 15 t ha<sup>-1</sup>. Application of 100 percent fertilizers application based on SSNM approach with target yield of 15 t ha<sup>-1</sup> recorded higher fresh pod yield (T<sub>3</sub>: 15.1 t ha<sup>-1</sup>) and it was on par with treatment had 100 percent fertilizers application based on STCR approach with target yield of 15 t ha<sup>-1</sup>. In spite of higher fertilizer cost, 100 percent fertilizers application based on SSNM and STCR approaches recorded higher net return of Rs. 2,61,995.0 and 2,60,302.0 ha<sup>-1</sup>, respectively. However, BC ratio returns per rupee invested on fertilizers was higher (4.8:1) in STCR approaches with target 15 t ha<sup>-1</sup> in alfisol soils of Karnataka.

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

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## Introduction

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 as hort 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 suitable. 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 [1]. Considering usefulness of STCR, and SSNM tools for nutrients management in French bean 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 bean crop and economic returns with optimum fertilizer application rate.

## Material and methods

The field experiment was conducted from 2014-15 to 2017-18 for four years at College of Horticulture, Munirabad (Koppal), University of Horticultural Sciences, Bagalkot situated on the latitude 15.295132°N, longitude 76.317623°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 mS m<sup>-1</sup>). The soil organic carbon content was 0.48 percent and soil were low in available nitrogen (275.0 kg ha<sup>-1</sup>), medium in available phosphorus (38.0 kg ha<sup>-1</sup>) and potassium (215.0 kg ha<sup>-1</sup>). The S-9 (Arka Komal) variety released by an IIHR, Bengaluru 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<sup>-1</sup>, with the different doses of fertilizers application as per the treatment details mentioned below.

The treatment details are as followed:

- T<sub>1</sub> : RDF as control
- T<sub>2</sub> : Application of fertilizers based on STV.
- T<sub>3</sub> : 100 % fertilizers based on SSNM approach with target yield of 15 t ha<sup>-1</sup>.
- T<sub>4</sub> : 75 % fertilizers based on SSNM approach with target yield of 15 t ha<sup>-1</sup>
- T<sub>5</sub> : 50 % fertilizers based on SSNM approach with target yield of 15 t ha<sup>-1</sup>.
- T<sub>6</sub> : 100 % fertilizers based on STCR approach with target yield of 15 t ha<sup>-1</sup>.

T<sub>7</sub> : 75 % fertilizers based on STCR approach with target yield of 15 t ha<sup>-1</sup>.

T<sub>8</sub> : 50 % fertilizers based on STCR approach with target yield of 15 t ha<sup>-1</sup>.

Where: RDF: Recommended Dose of Fertilizers

SSNM: Site Specific Nutrient Management

STCR: Soil test Crop Response

STCR equation for French bean 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 [2]. The details of equation are mentioned below.

F.N= 7.26078T- 0.27095 STV - 0.9856 OM

F. P<sub>2</sub>O<sub>5</sub>= 5.93010T- 0.78748 STV - 0.20549 OM

F. K<sub>2</sub>O= 9.04765T- 0.73354 STV - 0.29916 OM

Where,

T = Targeted yield 15 t ha<sup>-1</sup>

FN = Nitrogen supplied through fertilizer (kg ha<sup>-1</sup>)

FP<sub>2</sub>O<sub>5</sub> = Phosphorus supplied through fertilizer (kg ha<sup>-1</sup>)

FK<sub>2</sub>O = Potassium supplied through fertilizer (kg ha<sup>-1</sup>)

STV = Soil Test Value

OM= Organic matter percent 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<sup>-1</sup>, respectively based on several years of field studies. Further, the quantity of fertilizers required for a target yield of 15 t ha<sup>-1</sup> was worked out. The soil had lower in available nitrogen and medium supply for available phosphorus and potassium. Hence, we applied 12.5 percent 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 plant growth attributes included plant height, number of branches plant<sup>-1</sup>, number of leaves plant<sup>-1</sup> and number of pods plant<sup>-1</sup>, fresh pod weight (g plant<sup>-1</sup>), fresh pod weight (kg plot<sup>-1</sup>), fresh pod yield (t ha<sup>-1</sup>) at harvest of the crop. Pod yield from net plot area was converted into per hectare basis. Economic returns were worked out based on the prevailing market prices of input, cost of fertilizers and outputs. The experimental data were analysed statistically.

## Results and discussions

The pooled data on plant height in french bean crop recorded significantly. It showed that non-significance difference among the treatments at 30 days after sowing (DAS), the treatment with 100 percent fertilizers application through SSNM approach with target yield of 15 t ha<sup>-1</sup> recorded significantly higher plant height (34.2 & 46.4 cm at 30 DAS & at harvest, respectively) and it was on par with 100 percent fertilizers application through STCR approach with target yield of 15 t ha<sup>-1</sup> (33.7 & 44.1 cm at 30 DAS & harvest, respectively) where it was lowest in treatment with 50 percent fertilizers application through STCR approach with target yield of 15 t ha<sup>-1</sup> (28.7 & 33.1 cm at 30 DAS & harvest, respectively) (Table 1). The reduction in the plant height may be due to inadequate supply of nutrients. The results are in conformity with the findings of [3]. The number of branches plant<sup>-1</sup> in French bean crop showed the significant variation in pooled analysis for four years. The treatment with 100 percent fertilizers application through SSNM approach with target yield of 15 t ha<sup>-1</sup> recorded significantly highest number of branches plant<sup>-1</sup> (6.3 & 6.9 at 30 DAS & harvest, respectively) and STCR 15 t ha<sup>-1</sup> (6.0 & 6.7 at 30 DAS & harvest, respectively) at 30 DAS. The same trend of the results was observed at harvest (Table 2). The experimental data were pooled for four years it was observed that application of 100 percent fertilizers based on

SSNM approach with target yield of 15 t ha<sup>-1</sup> (10.3 & 16.3 at 30 DAS & harvest, respectively), it is on par with 100 percent fertilizers application through STCR approach with target yield of 15 t ha<sup>-1</sup>. The lowest number of leaves plant<sup>-1</sup> recorded with an application of 50 percent fertilizers based on STCR approach with target yield of 15 t ha<sup>-1</sup> (8.0 & 10.7 at 30 DAS & harvest, respectively). The same trend of results recorded with respect to number of leaves plant<sup>-1</sup> in French bean crop at harvest (Table 3). The higher number of leaves per plant was mainly due to adequate supply of nutrients and more leaf area exposed to sunlight with which rapid photosynthetic rate. Similar results indicating increased dry matter production due to increased levels of NPK was reported by [3] and [5]. The maximum number of pods plant<sup>-1</sup> was observed by application of 100 percent nutrients based on SSNM for a target yield 15 t ha<sup>-1</sup> (34.1) and STCR for target yield 15 t ha<sup>-1</sup> (33.0), while minimum number of pods plant<sup>-1</sup> was recorded in an application of 50 percent nutrients based on STCR for target yield 15 t ha<sup>-1</sup> (22.4). In case of fresh pod weight (g plant<sup>-1</sup>) showed that the same trends of results at harvest of french bean crop (Table 4). The higher pod yield of french bean crop was recorded with application of 100 percent fertilizers based on SSNM for a target yield of 15 t ha<sup>-1</sup> (T<sub>3</sub>: 15.1 t ha<sup>-1</sup>) and based on STCR target yield 15 t ha<sup>-1</sup> (T<sub>3</sub>: 14.9 t ha<sup>-1</sup>). Among other recommendations fertilizers application based on STV (T<sub>2</sub>: 13.0 t ha<sup>-1</sup>) and through RDF by University (T<sub>1</sub>: 12.7 t ha<sup>-1</sup>) were statistically on par. Significantly lower grain yield was recorded in treatment with an application of 50 percent fertilizers based on STCR target yield 15 t ha<sup>-1</sup> (T<sub>8</sub>: 9.4 t ha<sup>-1</sup>) (Table 5). As a consequence of higher plant height, number of branches plant<sup>-1</sup> and number of leaves plant<sup>-1</sup> helped production of more number of pods plant<sup>-1</sup>, fresh pod weight (g plant<sup>-1</sup>) 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 [6]. Yield attributes viz., number of pods plant<sup>-1</sup> and fresh pod weight (g plant<sup>-1</sup>) are significantly higher in application of 100 percent fertilizers based on SSNM for a target yield of 15 t ha<sup>-1</sup> and STCR target yield 15 t ha<sup>-1</sup> and lowest value were in application of 100 percent fertilizers based on STCR target yield 15 t ha<sup>-1</sup>. This is because of adequate quantity of nutrients supplied through SSNM and STCR approaches. These results corroborate with the findings of [3]. [7] showed importance of balanced fertilization for maintaining soil health and sustainable agriculture. [8] 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. The net income obtained from french bean production under 100 percent fertilizer application based on SSNM and STCR approach for a target yield of 15 t ha<sup>-1</sup> were (Rs. 2,61,995.0 and 2,60,302.0, respectively) (Table 6). The higher fertilizer cost in SSNM practice though slightly reduced B:C ratio, the improvement in soil fertility over years may reduce the input costs and thereby production under SSNM and STCR approach might become profitable and sustainable. Similarly profitable rice and wheat production under SSNM in Karnataka was reported by [4] in comparison with RDF and farmers practice. [9] 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 percent fertilizers based on SSNM with target yield of 15 t ha<sup>-1</sup> (T<sub>3</sub>) approaches giving more gross returns and net profit, the B: C ratio recorded was high in treatment with the application of 100 percent fertilizers based on STCR with target yield of 15 t ha<sup>-1</sup> (T<sub>6</sub>: 4.8:1) for french bean production under protective irrigation in Alfisol soils Karnataka (Table 6).

## Conclusions

The growth parameters namely plant height (34.2 & 46.4 cm), number of branches plant<sup>-1</sup> (6.3 & 6.9), number of leaves plant<sup>-1</sup> (10.3 & 16.3) were recorded significantly higher in treatment with 100 percent fertilizers application based on SSNM approach with target yield of 15 t ha<sup>-1</sup> in both 30 days after sowing and at harvest, respectively. Application of 100 percent fertilizers application based on SSNM approach with target yield of 15 t ha<sup>-1</sup> recorded higher fresh pod yield (T<sub>3</sub>: 15.1 t ha<sup>-1</sup>) and it was on par with treatment had 100 percent fertilizers application

Table-1 Effect of levels of fertilizers application through different approaches on plant height (cm) in french bean crop

Treatment	At 30 Days After Sowing				Pooled	At harvest				Pooled
	2014-15	2015-16	2016-17	2017-18		2014-15	2015-16	2016-17	2017-18	
T <sub>1</sub>	30.2	32.0	29.5	33.0	31.2	35.1	39.6	47.8	32.0	39.7
T <sub>2</sub>	30.5	32.7	32.0	32.7	32.0	38.0	40.3	49.0	34.2	41.3
T <sub>3</sub>	36.2	34.5	32.5	33.7	34.2	46.0	44.3	52.5	30.6	46.4
T <sub>4</sub>	29.5	31.3	29.1	32.3	30.6	34.0	36.2	44.7	29.0	37.5
T <sub>5</sub>	28.5	28.8	28.5	30.0	29.0	32.7	32.7	37.0	33.7	33.9
T <sub>6</sub>	34.7	34.3	32.3	33.3	33.7	43.5	43.0	50.7	29.8	44.1
T <sub>7</sub>	28.7	31.0	29.0	30.3	29.8	33.0	34.3	39.5	28.7	35.4
T <sub>8</sub>	28.4	28.4	28.2	29.67	28.7	32.6	32.6	34.3	0.7	33.1
S E m ±	1.7	1.1	1.1	1.3	0.7	1.80	1.18	2.12	2.12	0.72
C. D. (P=0.05)	4.93	3.12	NS	3.86	2.12	5.22	3.42	6.17	4.05	2.07
C V	9.54	12.74	6.49	7.22	4.05	8.44	11.64	8.28	31.2	3.17

Table-2 Effect of levels of fertilizers application through different approaches on number of branches plant<sup>-1</sup> in french bean crop

Treatment	At 30 Days After Sowing				Pooled	At harvest				Pooled
	2014-15	2015-16	2016-17	2017-18		2014-15	2015-16	2016-17	2017-18	
T <sub>1</sub>	5.9	5.6	4.3	5.3	5.3	5.8	6.3	5.9	6.3	6.1
T <sub>2</sub>	6.1	5.8	4.7	5.5	5.5	5.9	6.6	6.0	6.4	6.2
T <sub>3</sub>	6.6	6.0	6.3	6.2	6.3	7.1	7.4	6.3	6.8	6.9
T <sub>4</sub>	5.7	5.5	4.0	5.2	5.1	5.6	5.9	4.9	6.1	5.6
T <sub>5</sub>	5.3	5.3	3.5	4.8	4.7	5.0	5.2	4.0	5.4	4.9
T <sub>6</sub>	6.4	5.9	5.7	5.9	6.0	6.8	7.1	6.1	6.6	6.7
T <sub>7</sub>	5.6	5.4	3.8	5.0	4.9	5.6	5.9	4.3	6.0	5.5
T <sub>8</sub>	5.1	5.1	3.2	4.7	4.5	4.9	4.9	3.7	5.2	4.7
S E m ±	0.40	0.19	0.49	0.20	0.2	0.26	0.27	0.40	0.28	0.24
C D (P=0.05)	1.03	0.54	1.42	0.59	0.50	0.74	0.79	1.15	0.81	0.48
C V	10.52	12.58	19.03	6.54	5.65	7.60	16.58	13.27	7.93	4.91

Table-3 Effect of levels of fertilizers application through different approaches on number of leaves plant<sup>-1</sup> in french bean crop

Treatment	At 30 Days After Sowing				Pooled	At harvest				Pooled
	2014-15	2015-16	2016-17	2017-18		2014-15	2015-16	2016-17	2017-18	
T <sub>1</sub>	9.0	9.0	10.3	9.0	9.3	13.3	13.7	15.2	12.3	13.7
T <sub>2</sub>	9.3	9.3	10.3	9.7	9.6	13.5	14.5	15.4	13.7	14.3
T <sub>3</sub>	10.4	9.5	10.8	10.5	10.3	16.7	15.4	16.9	16.3	16.3
T <sub>4</sub>	8.7	8.7	10.0	8.7	9.0	12.1	11.5	15.0	11.3	12.5
T <sub>5</sub>	8.4	7.9	9.3	7.7	8.3	11.3	11.1	12.9	10.3	11.4
T <sub>6</sub>	9.9	9.4	10.7	10.3	10.1	16.0	15.0	16.1	16.0	15.8
T <sub>7</sub>	8.6	8.4	10.0	8.3	8.8	11.7	11.3	13.5	11.0	11.9
T <sub>8</sub>	8.2	7.5	9.2	7.0	8.0	10.7	10.7	12.5	9.0	10.7
S E m ±	0.35	0.38	0.49	0.86	0.3	0.64	0.40	0.54	1.04	0.41
C D (P=0.05)	1.02	1.11	1.41	2.51	0.93	1.87	1.16	1.57	3.02	1.08
C V	6.72	16.43	8.36	16.82	6.05	8.45	11.60	6.38	14.39	4.83

Table-4 Effect of levels of fertilizers application through different approaches on yield attributes at harvest in french bean crop

Treatment	Number of pods plant <sup>-1</sup>				Pooled	Fresh pod weight (kg plot <sup>-1</sup> )				Pooled
	2014-15	2015-16	2016-17	2017-18		2014-15	2015-16	2016-17	2017-18	
T <sub>1</sub>	28.3	29.3	29.4	29.4	29.1	9.1	9.0	7.3	10.0	8.8
T <sub>2</sub>	29.3	31.3	29.6	29.6	30.0	9.7	9.3	7.6	10.2	9.2
T <sub>3</sub>	35.7	36.7	32.0	32.0	34.1	11.3	10.1	8.1	11.3	10.2
T <sub>4</sub>	27.3	28.0	27.4	27.4	27.5	8.7	8.5	6.8	9.2	8.3
T <sub>5</sub>	23.7	25.3	24.4	24.4	24.5	6.4	6.8	5.5	7.2	6.5
T <sub>6</sub>	33.8	35.2	31.5	31.5	33.0	11.1	9.6	7.7	11.2	9.9
T <sub>7</sub>	27.0	27.7	24.9	24.9	26.1	8.4	7.6	6.6	7.6	7.6
T <sub>8</sub>	20.3	21.7	23.9	23.9	22.4	6.1	6.1	4.9	6.8	6.0
S E m ±	1.33	1.01	1.26	1.26	0.7	0.37	0.41	0.27	0.55	0.30
C D (P=0.05)	3.86	2.95	3.66	3.66	2.08	1.07	1.18	0.78	1.59	0.75
C V	8.15	5.98	7.83	7.83	4.38	7.18	8.37	6.87	10.29	5.37

Table-5 Effect of levels of fertilizers application through different approaches on yield at harvest in french bean crop

Treatment	Fresh pod yield (t ha <sup>-1</sup> )				Pooled
	2014-15	2015-16	2016-17	2017-18	
T <sub>1</sub>	12.3	12.0	13.5	14.0	12.7
T <sub>2</sub>	12.6	12.6	13.7	14.3	13.0
T <sub>3</sub>	15.8	15.5	14.2	16.0	15.1
T <sub>4</sub>	12.0	11.3	12.0	13.0	11.8
T <sub>5</sub>	9.6	9.8	10.7	10.2	9.8
T <sub>6</sub>	15.7	15.3	14.0	15.7	14.9
T <sub>7</sub>	11.7	10.7	11.3	10.7	10.8
T <sub>8</sub>	9.4	9.4	10.3	9.6	9.4
S E m ±	0.53	0.43	0.60	0.77	0.40
C D (P=0.05)	1.54	1.24	1.74	2.23	1.10
C V	7.43	13.26	8.33	10.29	5.35

Table-6 Economics of french bean crop production through different approaches in nutrient management practices under alfisols of Northern Karnataka

Treatment	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio	Cost on fertilizer
T <sub>1</sub>	59877	280747	220870	3.7	7677
T <sub>2</sub>	59352	286125	226773	3.8	7152
T <sub>3</sub>	57338	319333	261995	4.6	5138
T <sub>4</sub>	56064	259968	203904	3.6	3864
T <sub>5</sub>	54790	203100	148311	2.7	2590
T <sub>6</sub>	54217	314519	260302	4.8	2017
T <sub>7</sub>	53713	213423	159710	3.0	1513
T <sub>8</sub>	53209	192736	139527	2.6	1009
Note:	Price of french bean: Rs. 20 kg <sup>-1</sup>				
	RDF : Recommended dose of fertilizer			Cost of Urea: Rs. 6.2 kg <sup>-1</sup>	
	STV: Soil Test Value			Cost of DAP: Rs. 23.4 kg <sup>-1</sup>	
	SSNM: Site Specific Nutrient Management			Cost of MOP: Rs. 11.6 kg <sup>-1</sup>	
	STCR: Soil Test Crop Response			Cost of seeds: Rs. 120 kg <sup>-1</sup>	

based on STCR approach with target yield of 15 t ha<sup>-1</sup>. Proper and scientifically selection of approaches for the application of fertilizers during crop production should help in maximisation in crop growth, yield and to get more returns.

**Application of research:** Considering usefulness of STCR, and SSNM tools for nutrients management in French bean crop, and suitable approaches as best decision support system to enhance growth and yield of French bean crop and economic returns with optimum fertilizer application rate. Hence, it might helpful during crop productions and betterment to soil management for sustainable agriculture.

#### Abbreviations

MSL: mean sea level  
 SSNM: Site Specific Nutrient Management  
 RCBD: Randomized Completely Block Design  
 STCR: Soil test Crop Response  
 mSm<sup>-1</sup>: millisiemens per meter  
 STV: Soil test values  
 kg ha<sup>-1</sup>: kilogram per hectare  
 T: Target yield  
 t ha<sup>-1</sup>: tonne per hectare  
 FN: Fertilizer Nitrogen  
 AICRP: All India Coordinated research Project  
 FP: Fertilizer Phosphorus  
 RDF: Recommended Dose of Fertilizers  
 FK<sub>2</sub>O: Fertilizer Potassium  
 OM: Organic matter  
 DAP: Di-ammonium phosphate  
 MOP: Muriate of potash  
 DAS: Days after sowing  
 cm: Centimetre  
 g plot<sup>-1</sup>: Gram per plot  
 plant<sup>-1</sup>: Per plant  
 Rs.: Rupees

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