



STCR based nutrient management in chickpea (*Cicer arietinum*) for higher productivity and profitability

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ABSTRACT

Farmer' Participatory On Farm Trials (FP-OFT) were conducted at 10 different locations in Chandauli district of Uttar Pradesh during *rabi* 2016–17 in medium black soils to study the influence of soil test crop response (STCR) approach vis-a-vis farmers' practice on productivity and economics of chickpea (*Cicer arietinum* L.). Result revealed that targeted seed yield of chickpea (16 q/ha) was achieved by adoption of STCR approach. The mean grain and stover yields of chickpea under STCR were increased by 37.1% and 41.2%, respectively over the farmers' practice (FP). The plant height, number of root nodules, pods/plant and test weight of seed were also increased by 11.6, 29.3, 11.6 and 26.0% respectively, over the FP. There was much larger negative balance in available nitrogen and available potassium status under farmers' practice compared to STCR based nutrient management approach. The gross return, net returns and benefit-cost ratio (BCR) under the STCR approach were between ₹ 70200-77450/ha, ₹ 48019-55176/ha and 2.16-2.48 which were higher as compared to farmers' practice across the different locations. STCR based nutrient management approach should be adopted by the farmers for getting higher crop productivity and profitability and improving soil fertility status.

Keywords: Farmer participatory, Net return, On-farm testing, Soil Test Crop Response

Chickpea is commonly known as gram or Bengal gram. It is the most important pulse crop in India. Chickpea is grown by 22 states and 02 union territories of Dadar & Nagar Haveli and Delhi. It occupies about 35% of area under pulses and contributes about 50% of the total pulse production of India especially in Uttar Pradesh after Madhya Pradesh and Rajasthan. The area and production of chickpea in Uttar Pradesh are 5.05 lakh ha and 3.78 lakh tonnes, respectively. Chickpea productivity in Uttar Pradesh is about 748.51 kg/ha which contributes 38% of the total production of country being the maximum in Kanpur district (Agriculture and Cooperation Report, Ministry of Agriculture, Government of India 2011 -12). Unbalanced and inadequate use of fertilizers, low availability of essential nutrients and emergence of multiple nutrient deficiencies due to poor recycling of organic sources are responsible for low productivity of this protein rich crop (Chaturvedi *et al.* 2010). The use of fertilizers by the farmers in the field without consideration of soil fertility status and nutrient

requirement of crop causes adverse effects on soil health and crop creating nutrient deficiency either by inadequate use (Singh 2019). The soil test crop response (STCR) approach for getting target yield is unique to use of balanced fertilizer dose based on soil test and get higher yield that can be achieved with good agronomic practices (Singh *et al.* 2017). With this background, field trials were conducted to evaluate the STCR based nutrient management approach with farmers' practice (FP) using chickpea under medium black soils of Chandauli (UP).

MATERIALS AND METHODS

The farmers' participatory On Farm Trials (FP-OFT) on STCR based nutrient management with FP were conducted during *rabi* 2016–17 with chickpea as test crop on 10 different locations of two villages, viz. Persiya and Jharigawan of Naugarh block in Chandauli district of Uttar Pradesh. Soil samples (0-15 cm depth) were collected before sowing, dried in shade and passed through 2 mm sieve and analyzed for physico-chemical characteristics (Jackson 1973). Soil pH and electrical conductivity (EC) in (1:2): soil: water suspension was measured with the help of digital pH and EC meter (Richards 1954). The soil samples were analyzed for organic carbon by Walkley and Black method (1934), available nitrogen (Subbaiah and Asija 1956), phosphorus (Olsen *et al.* 1954) and available potassium by neutral ammonium acetate extract method

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(Hanway and Heidal 1952). In Persiya and Jharigawan villages, available N, P and K in initial soil samples varied from 184.2 to 218.4, 9.2 to 15.5 and 176.2 to 209.2 kg/ha, and from 183.2 to 217.9, 9.3 to 14.8 and 175.7 to 208.6 kg/ha, respectively. The pH and EC of both the villages were 6.5-7.4 and 0.30-0.39 dS/m, respectively.

The experiments were conducted with two treatments, viz. FP (Dose of N, P₂O₅ and K₂O varies from 5-15, 20-30 and 15-26 kg/ha) and STCR based fertilizers application for targeted yield of 16 q/ha in chickpea. The targeted yield of crop was ascertained as per yield potential of chickpea variety. The fertilizer prescription equations were developed by the AICRP, BHU centre of the project on STCR for chickpea crop under alluvial soils (Shiv *et al.* 2015). The amount of nitrogen, phosphorus and potassium for targeted yield of chickpea were calculated with the help of fertilizer adjustment equations:

$$FN = 5.35 T - 0.22 SN - 0.098ON$$

$$FP_2O_5 = 3.71 T - 1.16 SP - 0.15OP$$

$$FK_2O = 8.32 T - 0.43 SK - 0.22OK$$

where T, Yield target (t/ha); FN, Fertilizer N (kg/ha); FP₂O₅, Fertilizer P (kg/ha); FK₂O, Fertilizer K (kg/ha); SN, Soil available nitrogen (kg/ha); SP, Soil available phosphorus (kg/ha); SK, Soil available potassium (kg/ha); FYM, Farmyard manure (t/ha); ON, Organic nitrogen (kg/ha); OP, Organic phosphorus (kg/ha) and OK, Organic potassium (kg/ha).

The half dose of N and full dose of P₂O₅ and K₂O were applied to chickpea crop as basal and remaining half N after 27 days of sowing. Nitrogen, phosphorus and potassium were applied through urea, single super phosphate and muriate of potash respectively. The chickpea variety Pusa-364 (Hybrid) was used as test crop in both STCR based nutrient management and FP treatments. Data related

to plant growth, yield attributes and yield of chickpea crop were collected from each farmer fields and analyzed by adopting the standard procedures. Harvest index was estimated by Nichiporovich (1967). Harvest Index (%) = 100 × Economical grain yield of plot/biological yield of plot. Plant samples (grain and stover) were collected at harvest of crop for estimation of N, P and K content. Uptake of N, P and K by the crop was calculated separately as Uptake of nutrient (kg/ha) = nutrient content % × dry matter yield (kg/ha)/100. Benefit cost ratio (BCR) was also calculated to analyze the net returns from the chickpea crop under cultivation. The equation of net income/total cost was used to calculate the BCR.

RESULTS AND DISCUSSION

Nutrient requirement for targeted crop yield: The requirements of N, P₂O₅ and K₂O for different locations for achieving yield target of 16 q/ha were calculated using STCR prescription equations which varied 35.2-42.7, 39.7-46.7 and 38.9-53.0 kg/ha, respectively. Calculated amount of nutrients required for targeted yield of chickpea indicated that there were wide variations in nutrient requirements at different locations within the same village also. Therefore, the common recommendation for the crop does not hold significance. Thus, as per FP, farmers were not applying balanced/adequate dose of fertilizers. The fertilizers being applied by the farmers were much lower than crop requirements.

Plant growth and yield: The plant growth parameters as well yield attributes were obtained higher with STCR based nutrient management as compared to FP (Table 1). Highest plant height (32.7 cm) and number of root nodules/plant (45.7) were recorded under STCR based nutrient

Table 1 Growth parameters and yield (mean of two years) of chickpea under FP-OFT on STCR vis a vis a farmer practices at different location in Chandauli district, Uttar Pradesh

Location	Plant height (cm)		No. of pods/plant		No. of root nodules/plant		Weight of 100 seeds (g)		Grain yield (q/ha)		Stover yield (q/ha)		Harvest index (%)	
	FP	STCR	FP	STCR	FP	STCR	FP	STCR	FP	STCR	FP	STCR	FP	STCR
A	29.3	33.1	35.5	48.9	39.0	43.20	15.0	18.1	10.8	15.9	16.2	21.1	39.9	40.8
B	30.2	34.2	38.7	47.6	39.6	45.18	15.3	19.0	11.9	16.3	16.4	23.6	42.1	40.8
C	31.2	32.1	37.1	49.5	42.7	48.20	15.4	19.2	12.1	16.3	16.0	22.9	43.0	40.6
D	30.5	33.5	35.5	47.5	41.7	44.50	14.8	18.5	11.7	16.1	16.5	23.0	41.4	41.2
E	29.1	33.9	34.9	48.1	42.3	46.40	15.3	19.0	12.0	16.3	16.0	22.7	42.9	41.9
F	29.5	34.1	39.5	49.1	42.5	47.20	15.5	19.4	12.9	17.2	16.6	24.2	43.7	41.6
G	28.5	31.5	39.1	50.6	39.6	45.46	14.9	19.1	11.8	16.3	16.6	23.5	41.6	41.0
H	27.6	31.9	38.2	48.9	39.4	44.99	14.7	19.0	11.8	16.0	17.2	23.0	40.7	41.0
I	28.6	31.0	38.4	47.9	39.5	45.24	14.8	19.1	11.9	16.1	16.3	23.2	42.1	41.0
J	28.9	32.1	39.2	48.2	41.9	46.34	15.6	20.1	10.9	15.6	15.6	22.0	41.1	41.5
Mean	29.3	32.7	37.6	48.6	40.8	45.67	15.1	19.0	11.8	16.1	16.4	23.2	41.9	41.0
% increase over FP		11.6		29.3		11.9		26.0		37.1		41.9		

FP- Farmer practices; STCR soil test crop response; Name of locations: A, B, C, D, E. In Persiya village; F, G, H, I, J in Jhrigawan village

management approach as compared to FP at all the locations in both the villages. Better crop growth response under STCR approach may be due to balanced nutrient supply to the crop. The number of pods per plant ranged between 43.2 and 48.2 in soil test based fertilizers application, i.e. STCR, whereas in FP, it ranged from 39.0-42.7 pods per plant. The test weight of seed was higher in STCR approach as compared to FP. The grain and stover yields were recorded higher by 37.1 and 41.9%, respectively with STCR based fertilization as compared to FP. The grain yield under FP and STCR ranged from 10.8 to 12.9 q/ha and 15.9 to 17.2 q/ha, respectively (Table 1). Similarly, the stover yields under FP and STCR ranged from 15.6-17.2 q/ha and 21.1-24.2 q/ha, respectively. However, harvest index did not show any certain trend in both fertilizer practices. Higher yields of grain and stover under STCR based fertilization over FP was due to higher and balanced nutrient application to crop under STCR approach. Better supply of plant nutrients from different sources derived higher photosynthesis in STCR approach which resulted in superior crop harvest over the FP. Kumar *et al.* (2020) reported that targeted yield based fertilizer application in basmati rice increase the grain yield by 33-40% higher over farmer's practices. Higher system grain yield (9.74 t/ha) of pearl millet-wheat cropping system was recorded with STCR based integrated use of fertilizer with 10 t FYM/ha (Sharma *et al.* 2016).

Total nutrients uptake by chickpea: The soil nutrient management through STCR approach led to higher nutrient (N, P and K) total uptake as compared to FP of nutrient management. The total N uptake by chickpea crop (grain and stover) in FP ranged from 32.9-42.0 kg/ha with a mean value of 71.2 kg/ha. Whereas, under STCR approach, it ranged between 102.4 and 132.3 kg/ha with a mean of

36.2 kg/ha which showed an increase of 65.2% in nitrogen uptake over FP. Average total P uptake by chickpea was higher (14.7 kg/ha) with STCR approach than FP (12.8 kg/ha). The STCR based fertilizer management practice had average total potassium uptake (50.6 kg/ha) by chickpea crop than FP (35.5 kg/ha) which was 68.6% higher over FP. Since the uptake of nutrient is a function of dry matter and nutrient content, the higher biological yield resulted into higher N, P and K uptake. Similar results were reported by Singh *et al.* (2016).

Available nutrients in post-harvest soil: Post-harvest analysis of soil registered higher available N, P and K status in STCR approach. Available N, P and K in soil after harvest of crop under different locations with FP of nutrient management varied from 152.2-182.4, 6.28 to 10.20 and 149.2-178.2 kg/ha, respectively. Whereas with STCR based nutrient management practices the respective values were 174.3-205.1, 7.68-12.69 and 165.4-197.5 kg/ha, at different locations of FP-OFT. The significant improvement in available nitrogen, phosphorus and potassium was noticed under targeted yield based fertilizer recommendation in post-harvest soil after two years of trials (Kumar *et al.* 2020). Sharma *et al.* (2015) also reported that available major available nutrients were significantly increased except P with the application of STCR based integrated fertilizer.

Apparent nutrient balance at harvest: It was observed that there was higher negative balance in available N and available K under FP as compared to STCR. Apparent nutrient balance for available N, P and K were found to net negative under FP to the tune of 35.0, 3.73 and 27.9 kg/ha, respectively as compared to STCR approach. However, available P levels were more or less equal in both the management systems. This indicated that STCR based

Table 2 Total nutrients uptake and economics analysis of chickpea under FP-OFT on STCR vis a vis a farmer practices at different location in Chandauli district, Uttar Pradesh

Location	Total N uptake (kg/ha)		Total P uptake (kg/ha)		Total K uptake (kg/ha)		Cost of cultivation (₹/ha)		Cost of return (₹/ha)		Net return (₹/ha)		Benefit cost ratio	
	FP	STCR	FP	STCR	FP	STCR	FP	STCR	FP	STCR	FP	STCR	FP	STCR
A	32.9	54.7	12.8	20234	22422	48375	71550	16.8	26.2	47.6	71550	16.8	26.2	47.6
B	37.0	60.0	15.0	19480	22353	53550	73125	17.0	29.9	50.5	73125	17.0	29.9	50.5
C	38.5	58.0	16.7	19260	22596	54270	73350	17.0	29.0	52.5	73350	17.0	29.0	52.5
D	36.4	57.8	14.1	18946	22176	52425	72450	16.9	30.9	50.1	72450	16.9	30.9	50.1
E	36.5	62.2	16.2	19301	22223	54000	73350	18.0	29.1	56.0	73350	18.0	29.1	56.0
F	42.0	65.5	16.7	19877	22224	58050	77400	19.9	35.5	57.8	77400	19.9	35.5	57.8
G	35.0	56.9	14.4	18926	22124	53280	73350	18.1	32.9	52.0	73350	18.1	32.9	52.0
H	34.1	64.5	14.1	20670	22299	53100	71775	16.9	25.9	46.0	71775	16.9	25.9	46.0
I	33.3	54.9	13.7	18552	22120	53325	72450	18.0	26.5	48.1	72450	18.0	26.5	48.1
J	36.3	63.5	13.0	18558	22181	49050	70200	17.2	34.5	45.2	70200	17.2	34.5	45.2
Mean	36.2	59.8	14.7	19380	22272	52943	72900	17.6	30.0	50.6	72900	17.6	30.0	50.6
% increase over FP		65.2						20.1		68.6		20.1		68.6

FP- Farmer practices: STCR soil test crop response: Name of locations: A, B, C, D, E. In Persiya village: F, G, H, I, J in Jhrigawan village

fertilizer application not only gave better nutrition to crop but also left the soil in better nutrient status for crops.

Economics: The nutrient management through STCR based approach led to higher gross and net returns as well as benefit: cost ratio as compared to FP. However, cost of cultivation were slightly higher with STCR (₹ 33852/ha) compared to FP (₹ 29480/ha). The gross return in FP ranged from ₹ 48375-28475/ha, whereas in STCR, it varied between ₹ 70200/ha - 74250/ha. Similarly, the net returns under FP and STCR ranged from ₹ 18895-27220/ha and ₹ 36348 - 40398/ha, respectively. On an average, there was a benefit of ₹ 15405/ha due to balanced fertilization based on STCR over FP (Table 2). Benefit cost ratio was also higher in STCR over FP. Higher cost of cultivation in STCR may be due to higher amount of fertilizers and management cost. But, it was compensated by higher crop productivity. Higher gross and net returns and benefit cost ratio was due to higher crop productivity. Kumar *et al.* (2020) also reported that net profit in rice was recorded higher with STCR based fertilizers application.

It was concluded that in chickpea crop, growth, yield attributes, yields of grain and stover, net return, benefit cost ratio and soil available nutrients in post-harvest soil were higher under STCR approach over FP. Thus, STCR approach may be advised for it's used by the farmers seeking higher crop productivity, profitability and improvement in soil fertility.

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