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Impact of nutrient management technologies in chickpea under irrigated condition of Chandauli district, Uttar Pradesh

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Abstract
The present study was conducted a farmer field Sri. Chander Shekhar, Kharwar in Hadai village of Naugarh block in Chandauli district during the year 2014-15, to study the Impact of nutrient management technologies in chickpea. An experiment on impact of different approaches of nutrient management in chickpea was conducted in participatory mode on mixed red to shallow black soils under irrigated condition of Chandauli district, Uttar Pradesh. The target yield of chickpea 12 q ha^{-1} achieved with application of N:P:K as 19:16:13 along with 5 t ha^{-1} farm yard manure (FYM) and target yield of 16 q ha^{-1} is achieved with application of N:P:K as 40:29:26 along with 5 t ha^{-1} farm yard manure (FYM). Under farmers condition of chickpea cultivation B:C ratio is 0.95, under general recommendation of agricultural department of the district on the basis of soil test value condition of chickpea cultivation B:C ratio is 1.39, and under STCR for 16 q ha^{-1} in chickpea variety test crop condition is B:C ratio is 2.98. The nutrient content by crop and soil nutrients status was higher after harvest of chickpea cultivation when NPK were applied with FYM. It was inferred from the study that the STCR technology may be the appropriate approach for optimum nutrient supply which improves the soil properties especially the soil health and productivity in a long run in comparison to other nutrient management technologies.

Keywords: Chickpea, target yield, soil test crop response FYM and B:C ratio etc

Introduction
Chickpea is commonly known as gram or Bengal gram. Chickpea occupies about 35 per cent of area under pulses and contributes about 50 per cent of the total pulse production of India especially in Utter Pradesh after Madhya Pradesh and Rajasthan. The area and production of chickpea in Uttar Pradesh are 5.25 lakh hectare and 3.98 lakh tonnes respectively. Chickpea productivity in Utter Pradesh is about 756.51 kg ha^{-1}. About 38.25% of the total production of country is from Uttar Pradesh and maximum in Kanpur district (Agriculture and Cooperation Report, Ministry of Agriculture, Government of India 2013 -14).
Several approaches have been used for fertilizer recommendation based on chemical soil test so as to attain maximum yield per unit of fertilizer use. Among the various approaches, the target yield approach has found popularity in India (Subba Rao and Srivastava, 2000) [17]. This method not only estimates soil test based fertilizer dose but also the level of yield the farmer can achieve with that particular dose. However, application of N, P and K fertilizer on soil test target yield based may meet the productivity but it has negative impact on soil health, hence, integrated nutrient management *i.e.* combination of inorganic and organic in chickpea crop help to enhance the barley and rice productivity while maintaining the soil health (Ghosh, 2008) [5]. It gives a real balance between applied nutrients and the available nutrients already present in the soil. Keeping the above facts in view and non-availability of quantitative study of fertilizers requirements based on target yield for chickpea in Indo-Gangetic plains of Uttar Pradesh this study was conducted. The objective of this paper was to study the response of chickpea to manure and fertilizer application, estimate the nutrient requirement of chickpea and develop quantitative relationships to estimate fertilizer requirement for target yield of chickpea and also discuss the economics.

Materials and Methods
On farm trials were conducted at village–Hadai, block - Naugarh of Chandauli district, Uttar Pradesh, India during *Rabi* 2014-15 on alluvial soil (Inceptisol). The soil of experimental field of chickpea was sandy loam with mean value of pH 7.3, EC 0.22 dSm^{-1}, Organic carbon 2.7 g kg^{-1} and available N, P_2O_5 and K_2O 115.35, 18.80 and 255.80 kg ha^{-1}, respectively. Quantities of nitrogen, phosphorus and potassium were calculated with the help of fertilizer adjustment equations developed by (Mishra, *et al.* 2015) [9] as following 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; FN, FP and FK is fertilizer N, P_2O_5 and K_2O (kg ha^{-1}), respectively; SN, SP and SK are available N P and K of soil (kg ha^{-1}) and ON, OP and OK are available N P and K of farm yard manure (%), respectively.

Five fertilizers treatments viz., Control, Farmers practice, General recommendation dose of fertilizer, Soil test crop response (STCR) for 12 q ha^{-1} with 5 t ha^{-1} farm yard manure and Soil test crop response (STCR) for 16 q ha^{-1} with 5 t ha^{-1} farm yard manure in chickpea (gram) variety of test crop was Pusa – 364 (Hybrid), 12 q ha^{-1} and 16 q ha^{-1} targeted yield were taken. The targeted yield of crop was decided as per yield potential of varieties. Pre sowing soil samples were analyszed according to the standard procedures. The chickpea (gram) variety of test crop was Pusa–364 (Hybrid) sown in the second week of November, 2014 and harvested of third week of April, 2015. The grain yield in chickpea crop was recorded after harvesting of crop. Nutrient content was determined by analyzing the entire plant sample collected randomly from each plot at harvest. Plant nutrient content were analyzed following the standard methods of N, P, and K analysis (Piper, 1944) [11]. Soil samples (0-15 cm in depth) were collected random from each plot immediately after harvest dried and passed through 2 mm sieve and analyzed for physico chemical properties as described by Jackson (1973)[8]. Available nitrogen, by the alkaline permanganate method (Subbiah and Asija, 1956) [18], available phosphorus, by Olsen method (Olsen *et al*., 1954) [10] and available potassium, by the ammonium acetate method (Hanway and Heidal, 1952) [7] as described by Jackson (1973) [8]. The economics in term of benefit cost ratio was also calculated at price prevailing in nearest market. The grain yield of chickpea, and other parameters of nutrient dynamics were subjected to standard analysis of variance (ANOVA) and treatment differences were tested following tests of least significant difference (LSD) at statistical significance level of $P \leq 0.05$ (Gomez and Gomez, 1984) [6].

Results and discussion

Impact of nutrient management on yield

Grain and straw yields were found in increasing trend to that of the preceding treatments over T_1 and these were varied from 7.80 to 15.80 and 11.50 to 24.50 q ha^{-1} respectively, among the judged treatments. Among the treatments remarkable difference was also noticed in above parameters. The extent of increase in grain yield was noted to be 12.35, 25.71, 34.73 and 50.63% over control (T_1). Similarly the increase in straw yield was recorded to be 20.68, 33.14, 41.92 and 53.06% in the preceding treatments over T_1 (control). It was observed from the Table 1 that use of organic FYM along with NPK fertilizers applied through STCR equation in T_5 treatment resulted in greater values for all the parameters under observation followed by T_3 (GRD on soil test basis) and T_1 (blanket dose of NPK without soil test) which is also mirrored by the per cent increase in grain and straw yields of chickpea in which the extent of increase was remarkably higher in the above said treatments. Application of fertilizers based on STCR equation in NPK with organic in T_5 treatment might have facilitated the applied nutrients efficiently according to the need of crop and enriched nutrient reserve in soil which lead to better content of the nutrients by the crop. The results indicate that higher yield target may be achieved through integrated supply of nutrients from different sources. Similar findings were reported by Apoorva *et al.* (2010) [1]. Fertilizers application through STCR technology in T_4 treatment resulted in 11.95 q ha^{-1} grain yield which was nearly 87.87% of the established target and it was appreciably higher than that of T_3 treatment (GRD). The parameters under study were substantially greater in comparison to T_1 (Blanket application of NPK without soil test) as the soil test based application of nutrients in GRD, and fulfilled the crop need to the considerable extent. The integration of inorganic with organic (FYM) was ensured the achievement of target yield of chickpea only inorganic N, P and K didn’t achieve the target yield in the chick pea. Balanced nutrition to solve, through integration of both organic and chemical nutrient sources appears to be essential. It provides adequate nutrients to crop uptake which promotes chickpea growth and subsequent development of yield attributes lead to higher yield (Ghosh, 2008) [5]. Target yield was not achieved exactly, showing a slight deviation from the grain yield was might be due to unavailability of the full amount of applied nutrients to plant as estimated to achieve the targeted yield. One possibility is that release of nutrients from applied fertilizer occurs spontaneously; however, subsequent uptake by plant is not taking place concurrently. Thus, entry amount of applied fertilizer could not have been up took due to lack of synchronization of its release with its absorption by plant, accounting for uncontrollable losses (Balasubramanian, *et al.*, 2003) [2]. The combination of inorganic and organic resulted in higher productivity of chickpea and wheat was also reported by Singh, *et al.* (2014) [14] in rice and Singh, *et al.* (2015) [15] in wheat.

Nutrient content in grain and straw of chickpea

The higher nutrient content (3.60 N, 0.92 P and 1.06 K kg ha^{-1}) by chickpea grain and (1.82 N, 0.58 P, 2.30 K kg ha^{-1}) by chickpea straw was recorded under T_5 superior than other treatments (table 2). The lowest uptake of nutrients under treatment T_1 it is no application of fertilizer by (NPK nutrients). Available nutrients status was also higher in T_4 and T_5 where FYM was applied. When we apply FYM in soil the entire amount of its NPK constituents was not made available at a time in one season; rather, a gradual release took place over a period of years. It has been reported that only 25% to 30% N, 16% to 70% P, and 75% K could be made available from applied FYM in first season rice and the remainder being available in subsequent years (Gaur *et al.*, 1984) [4]. Hence, comparatively less yield deviation under integrated nutrients management was attributed to slow but sustained release of nutrients and due to improvement in humic substances in soil, which in turn promotes the NPK status

Economic performance

The data given in table 3 dealt with economics of chickpea cultivation under various treatments and reveal that the net benefit was remarkably higher with the STCR technology treatments. Highest benefit cost ratio was observed in T_5 (STCR equation based NPK application with FYM) with value of an additional yield of Rs.24000 followed by STCR equation based NPK with FYM application only in T_4 (Rs.12450), general recommendation dose in T_3 (Rs.8100) and farmer practice T_2 (Rs.3300) treatments over (control) respectively. The BC ratio was remarkably higher in STCR treatments *viz.* T_4 and T_5 in comparison to that of GRD, farmer practice and blanket application of NPK fertilizers. It was also observed that the BC ratio was nearly twofold in the

T_4 treatment in comparison to that of farmers' practice which divulges the effective and efficient utilization of the fertilizers through STCR technology. The benefit cost ratio was significantly 2.06 and 2.98 higher in T_4 and T_5, where FYM was integrated with ST-TY based application of NPK compared to T_1, T_2 and T_3 treatments (table-1). Similar trends were noticed in earlier findings of Bera *et al.* (2006) [3] and Ramanaiah *et al.* (2012) [13].

Soil fertility status after harvest of chickpea crop

The average value of the soil physicochemical properties and fertility parameters (before sowing and after crop harvest) given in table 3 indicates that initially the soils were neutral in reaction with average pH 7.3 and low in soluble salts (0.22 dSm^{-1}) which was observed to be neutral with less soluble salt concentration after chickpea crop in *rabi* season in all the treatments. The organic carbon content which was earlier measured low (0.27%) in the experimental fields before sowing, increased in all the treatments except control in 2014-15. The organic carbon content was noticed to be remarkably high in STCR treatments especially in T_5. The soils were very low in N (115.35 kg ha^{-1}), medium in P_2O_5 (18.80 kg ha^{-1}) and high in K_2O (255.80 kg ha^{-1}) before chickpea sowing. The available N increased in all the treatments except control, however, the remarkable rise was observed in STCR treatments as it arose in low category from very low and it varied from 180 to 200 kg ha^{-1}. The P and K status also improved in all the treatments except T_2 (farmers' practice) in case of K and T_2 in case of P. Despite higher removal of nutrients, the fertility status was maintained in STCR-INM as compared to the general recommendation and farmer practice. This might be attributed to the preventation of losses of nutrients under INM, even after meeting the crop needs. Greater profit consistent with maintenance of soil fertility status was realized when fertilizer was applied for appropriate yield targets in succession over years using STCR-INM concept (Ramamoorthy and Velayutham, 2011) [12]. Santhi *et al*. (2011) [14] established that soil test based fertilizer prescription for beet root was found to be useful in increasing yield and also maintained soil fertility. The higher values of these parameters were noted in STCR treatments especially in T_5 due to use of FYM which helped in increasing P; however, the availability class in the soil for these parameters remained as such. These results suggest that the specific yield based on STCR equation not only optimizes the T_5 crop yield to the desired level but maintains the better soil health which is a prime factor for sustainable crop production. The above findings suggest that STCR technology may be the appropriate approach for optimum nutrient supply which improves the soil properties especially the soil health and productivity in a long run in comparison to T_5 over T_2. The results indicated that the integrated nutrient supply with inorganic fertilizers through STCR approach is necessary for both productivity and sustainability and it also results in higher net benefit and BC ratio.

Table 1: Yield and economics of verification trails for chickpea crop

Treatments	Fertilizer dose NPK (kg ha^{-1}) and FYM (t ha^{-1})	Actual mean yield (q ha^{-1})	Actual mean straw yield (q ha^{-1})	Additional yield (kg ha^{-1})	Value of additional yield (Rs.)	Cost of fertilizer (Rs.)	Net benefit (Rs.)	B/C ratio
T_1-Control	0-0-0	7.80	11.50	-	-	-	-	-
T_2 - FP	10-20-15	8.90	14.50	110	3300	1693	1607	0.95
T_3- GRD	20-40-30	10.50	17.20	270	8100	3386	4714	1.39
T_4-12q ha^{-1}	19-16-13-5	11.95	19.80	415	12450	4072	8378	2.06
T_5-16q ha^{-1}	40-29-46-5	15.80	24.50	800	24000	6035	17965	2.98
LSD (P=0.05)		0.120	0.309					

Note: Chickpea@Rs.30.00/kg, N@Rs.17.39/kg P_2O_5@Rs.56.25/kg, K_2O@Rs.26.66/kg, FYM@Rs.0.50/ha.

A miner modification was made in the ready reckoner, FP: Farmers practice i.e. the fertilizer doses the farmers generally applied in the area, GRD: General recommendation of agricultural department of the district on the basis of soil test value, B: C ratio: benefit cost ratios

Table 2: Nutrients content of grain and straw in chickpea after harvest of different treatments

Treatments	Fertilizer dose NPK (kg ha^{-1}) and FYM (t ha^{-1})	Grain (kg ha^{-1})			Straw (kg ha^{-1})		
		N	P	K	N	P	K
T_1-Control	0-0-0	1.67	0.43	0.54	1.19	0.14	1.38
T_2 - FP	10-20-15	2.10	0.54	0.65	1.37	0.27	1.79
T_3 - GRD	20-40-30	2.54	0.74	0.80	1.52	0.36	1.98
T_4-12 q ha^{-1}	19-16-13-5	2.74	0.87	0.93	1.70	0.43	2.41
T_5-16 q ha^{-1}	40-29-46-5	3.60	0.92	1.06	1.82	0.58	2.30
LSD (P=0.05)	-	0.155	0.021	0.074	0.040	0.016	0.102

Note: A miner modification was made in the ready reckoner, FP: Farmers practice i.e. the fertilizer doses the farmers generally applied in the area, GRD: General recommendation of agricultural department of the district on the basis of soil test value.

Table 3: Available nutrient status of soil before sowing and after harvest of chickpea crop

Treatments	Physiochemical properties						Fertility status(kg ha^{-1})					
	pH		EC(dSm^{-1})		OC (%)		N		P_2O_5		K_2O	
	BS	AH	BS	AH	BS	AH	BS	AH	BS	AH	BS	AH
T_1-Control	7.3	7.4	0.22	0.26	0.27	0.20	115.35	95	18.8	21.0	255.8	224.3
T_2 - FP	7.3	6.9	0.22	0.29	0.27	0.30	115.35	143	18.8	18.2	255.8	258.4
T_3 - GRD	7.3	7.1	0.22	0.20	0.27	0.34	115.35	157	18.8	19.6	255.8	247.8
T_4-12 q ha^{-1}	7.3	7.2	0.22	0.17	0.27	0.41	115.35	180	18.8	22.1	255.8	262.2
T_5-16 q ha^{-1}	7.3	6.9	0.22	0.20	0.27	0.50	115.35	200	18.8	24.7	255.8	265.5
LSD (P=0.05)	-	0.01	-	0.002	-	0.01	-	3.50	-	0.75	-	6.59

Note: A miner modification was made in the ready reckoner, FP: Farmers practice i.e. the fertilizer doses the farmers generally applied in the area, GRD: General recommendation of agricultural department of the district on the basis of soil test value, BT- Before sowing, AH-After crop harvest.

Conclusion

The study thus revealed that the targeted yield in chickpea could be achieved within ±5% deviation with STCR technology; however, the integrated nutrient supply using STCR approach optimized the yield level to the desired target. The enhanced productivity of chickpea may be accredited to improved soil properties and better nutrient use efficiency of applied nutrients.

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