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Soil test crop response approach for chickpea in an Inceptisol

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Abstract
A field experiment "Nutrient requirement of chickpea by conjoint use of organic manures and chemical fertilizers based on targeted yield approach on Inceptisol" The data on initial soil test values for NPK, pod yield, NPK uptake and fertilizer nutrients applied were used to calculate the basic parameters viz., nutrient requirement (NR), contribution from soil (CS %), contribution from fertilizer (CF %) and per cent contribution from FYM.

The nutrients required to produce one quintal chickpea are 1.53 N, 0.26 P and 1.72 K kg q-1 respectively. The contribution of soil is 9.32, 15.95 and 6.03 per cent for N, P and K respectively. The per cent contribution of fertilizer without FYM is 55.27 percent for N, 8.10 per cent for P and 56.61 percent for K and it was increased as 60.6 percent for N, 9.8 percent for P and 64.0 percent for K in presence of FYM. The data on basic parameters viz, nutrient requirement, contribution from soil, contribution from fertilizer, soil test values, uptake of NPK nutrients and yield were used to formulate the fertilizer prescription equations for chickpea (cv. Phule Vikram) on Inceptisol.

Keywords: Chickpea yield targeting approach equation Inceptisol

Introduction

Millions of farmers in developing countries need adequate resources for augmenting the crop production potential. Due to price hike of chemical fertilizers and poor purchasing ability of marginal and sub-marginal farmers, it is imperative to develop strategy to use organics to its minimum potential with proper technology to meet the shortage of fertilizers and for improving the soil fertility. In recent years, the concept of integrated nutrient supply system involving combined use of organics and chemical fertilizers is being developed. The use of adequate doses of organic manures coupled with chemical fertilizers will ensure optimum growth conditions under intensive cropping system with high yielding varieties. Various approaches have been tried to determine the amount of fertilizer needed for different crop yield. Among different approaches the targeted yield approach has proved its variation in the recommendation of chemical fertilizers to variety of crops.

Chickpea (*Cicer arientinum*) is the world 3rd most important source of food legume crop. Chickpea grains are rich source of protein contains about 23% protein, 57% carbohydrates and 5% fat (Jukanti *et al*. 2012) [8]. It is also good source of vitamine B and minerals like potassium, phosphorus and zinc.

In India, chickpea is grown on an 8.59 million ha area with 7.05 million tonne production (Anonymous, 2016) [2]. In Maharashtra chickpea is grown on 1.44 million ha area with 0.73 million ton production. The average productivity of chickpea in India is 840 kg ha^{-1} which is considerably low as compared to the production potential of the improved cultivars of chickpea. The productivity of chickpea can be increased by judicious and balanced fertilization. Fertilizer management through Integrated Plant Nutrient Supply (IPNS) based yield target fertilizer prescription equations can be the best option for increase in productivity as well as maintaining the soil health.

IPNS based yield target approach includes, site specific knowledge of crop nutrient requirements. Soil nutrient supply and recovery efficiency of applied fertilizer which are required to sustain high yields and maintain or build up soil fertility at a such level that ensure maximum efficiency from nutrient inputs (Pathak *et al*. 2003). This method not only estimates soil test based fertilizer dose but also the level of yields that the farmers can achieve with that particular dose.

Material and Methods

The present investigation entitled "Nutrient requirement of chickpea by conjoint use of organic manure and chemical fertilizers based on targeted yield approach on Inceptisol" was conducted at Pulse Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2016-17. The details of the material used and analytical techniques adopted for this investigation are presented in this chapter Geographically the Central Campus of Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S) is situated 30 km from Ahmednagar on Ahmednagar-Manmad State highway. It lies between $19^0 48'$ N and $19^0 57'$ N latitude, $74^0 19'$ E longitude and altitude of 532 above mean sea level.

The average minimum and maximum temperature during growing period of chickpea crop was 26.5 ^{0}C to 40.5 ^{0}C and 8.5 to 21.5 ^{0}C respectively. The morning and evening relative humidity during the crop growth period was 36.14 to 87.29 and 13.57 to 53.28 per cent in morning and evening respectively. Total rainfall during *rabi* crop growing period was only 15.8 mm. Sowing was done on 24^h November, 2016. The soils of experimental plot is grouped under the Inceptisol and classified as fine montmorillonitic hyperthermic family of *Vertic Haplustept* (Masala soil series).

The soil of experiment site is clayey in texture, slightly alkaline (pH 8.15) in nature, medium in calcium carbon content (9.36%), low in organic carbon and soil available nitrogen (0.37% and 215 kg ha^{-1} respectively), medium in available phosphorus (16 kg ha^{-1}) and high in potassium content (358 kg ha^{-1}).

Healthy chickpea grains of variety Phule Vikram, recently released by university obtained from Chief seed Sale Counter, M.P.K.V, Rahuri.

The recommended dose of fertilizers for chickpea was 25:50:30 kg ha^{-1} N, P_2O_5 and K_2O. The N was given through urea, P through single super phosphate and K_2O through Muriate of potash. Organic manures i.e. farm yard manure was given @ 0, 5 and 10 t ha^{-1} to F_0, F_1 and F_2 blocks respectively. The surface soil samples were collected prior to application of FYM and fertilizer for their initial nutrient.

The sowing of chickpea grain was done on 24th November, 2016. The chickpea grains were sown at spacing of 30×10cm^2 The chickpea plants in net plots after full maturity were harvested carefully and recorded the grain and straw yield from each net plot.

The experimental field was divided into three equal strips *viz*., L_0, L_1 and L_2 for creating fertility gradient. The gradients were developed by applying graded doses of N, P_2O_5 and K_2O fertilizers. The fertility gradient was stabilized by growing the fodder maize. The fodder maize was harvested at tasseling and prepared the land without disturbing individual fertility gradient strip for sowing of chickpea.

Table 1: Treatment wise fertilizer application to chickpea

S. No.	Treatment	Nutrient added (kg ha^{-1})			Fertilizer added (kg ha^{-1})			Fertilizer added (g plot^{-1})		
		N	P_2O_5	K_2O	Urea	SSP	MOP	Urea	SSP	MOP
1	$N_3P_2K_2$	37.5	50	30	81.38	312.5	50.1	98	375	60.12
2	$N_2P_2K_2$	25	50	30	54.25	312.5	50.1	65.1	375	60.12
3	$N_1P_2K_2$	12.5	50	30	27.12	312.5	50.1	32.55	375	60.12
4	$N_2P_2K_3$	25	50	45	54.25	312.5	75.15	65.1	375	90.18
5	$N_2P_2K_1$	25	50	15	54.25	312.5	25.05	65.1	375	30.06
6	$N_2P_3K_2$	25	75	30	54.25	468.75	50.1	65.1	563	60.12
7	$N_2P_1K_2$	25	25	30	54.25	156.25	50.1	65.1	188	60.12
8	$N_3P_3K_1$	37.5	75	15	81.37	468.75	25.05	97.65	563	30.06
9	$N_2P_3K_3$	25	75	45	54.25	468.75	75.15	65.1	563	90.18
10	$N_3P_2K_1$	37.5	50	15	81.37	312.5	25.05	97.65	375	30.06
11	$N_3P_3K_2$	37.5	75	30	81.37	468.75	50.01	97.65	563	60.12
12	$N_2P_1K_1$	25	25	15	54.25	156.25	25.05	65.1	188	30.06
13	$N_1P_1K_1$	12.5	25	15	27.12	156.25	25.05	32.55	188	30.06
14	$N_1P_1K_2$	12.5	25	30	27.12	156.25	50.1	32.55	188	60.12
15	$N_1P_2K_1$	12.5	50	15	27.12	312.5	25.05	32.55	375	30.06
16	$N_3P_2K_3$	37.5	50	45	81.37	312.5	75.15	97.65	375	90.18
17	$N_3P_3K_3$	37.5	75	45	81.37	468.75	75.15	97.65	563	90.18
18	$N_3P_1K_1$	37.5	25	15	81.37	156.25	25.05	97.65	188	30.06
19	$N_2P_2K_0$	25	50	00	54.25	312.5	00	65.1	375	00
20	$N_2P_0K_2$	25	00	30	54.25	00	50.1	65.1	00	60.12
21	$N_0P_2K_2$	00	50	30	00	312.5	50.1	00	375	60.12
22	$N_0P_0K_0$	00	00	00	-	-	-	-	-	-
23	$N_0P_0K_0$	00	00	00	-	-	-	-	-	-
24	$N_0P_0K_0$	00	00	00	-	-	-	-	-	-

Three FYM blocks were superimposed across the fertility gradient by applying 0, 5 and 10 t ha^{-1} FYM. Each fertility gradient were subdivided into 24 sub plots. The surface soil samples was collected prior to application of FYM and fertilizer for their initial nutrient status. Twenty one treatment combinations of N, P_2O_5 and K_2O along with three control were superimposed on each fertility strip in such way that all the 24 combination appear in each fertility gradient block as well as FYM block and then chickpea grain (Cv. Phule Vikram) was sown. The surface soil samples at harvest of chickpea were collected and analyzed for pH, EC, available N, P, K, organic carbon, calcium carbonate and DTPA-micronutrients.

The grain and straw yield of chickpea was recorded. The treatment wise plant and grain samples were collected from each plot and analysed for the nutrient concentration and subsequent nutrient uptake was conducted from each plot.

The soil samples were collected from each plot before sowing of main chickpea crop. The collected soil samples were air

dried in shade, gently ground, mixed and sieved through 2 mm sieve for laboratory analysis.

Fertilizer application to fodder maize crop

S. No	Fertility gradient	Nutrient applied to the fodder maize (kg ha^{-1})		
		N	P_2O_5	K_2O
1.	L_0	00	00	00
2.	L_1	100	50	50
3.	L_2	200	100	100

Fertilizer nutrient applied to chickpea

S. No	FYM levels (t ha^{-1})	Nutrient applied (kg ha^{-1})		
		N	P_2O_5	K_2O
1	0	00	00	00
2	0	12.5	25	15
3	5	25	50	30

The representative grain and straw samples were collected from each plot after harvest of main chickpea crop. The collected plant samples were air dried in shade and later oven dried at 65 ^{0}C ± 5 ^{0}c and ground to fine powder and used for chemical analysis.

In this approach nutrient requirement (NR) and contribution from fertilizer (CF) values were calculated from all the treated plots and contribution from soil (CS) values were calculated from control plots. The NR (kg q^{-1}), (CF %) and (CS %) values were calculated according to formulae given by Dev *et al*. (1978). The mean values for NR and CF for NPK were calculated from 63 treated plots (kg g^{-1}) of chickpea and percent contribution from fertilizer, respectively. The mean values of soil contribution (CS) for NPK were considered from 3 control plot of F_0 block. From these basic data, the fertilizer adjustment equations were derived.

Basic data required for computation of fertilizer prescription equation (without FYM application)

$$\text{Nutrient requirement for one quintal production (NR) (kg q}^{-1}) = \frac{\text{Total uptake of nutrient (kg ha}^{-1})}{\text{Grain yield (q ha}^{-1})} \quad \text{i)}$$

$$\text{Per cent contribution from soil available nutrients (CS\%) (NPK)} = \frac{\text{Total uptake of nutrient (kg ha}^{-1}) \text{ in control plots}}{\text{Soil test values for NPK, (kg ha}^{-1}) \text{ in control plots without FYM}} \times 100 \quad \text{ii)}$$

$$\text{Per cent contribution from fertilizer (CF\%)} = \frac{\left(\text{Total uptake of nutrient in treated plots without FYM (kg ha}^{-1})\right) - \left(\text{STV of control plot without FYM}\right)}{\text{Fertilizer dose (kg ha}^{-1}) \text{ in treated plot without FYM}} \times 100 \quad \text{iii)}$$

The nutrient requirement, contribution from soil nutrients and contribution from fertilizer nutrients, were calculated separately N, P and K and average were taken for computing fertilizer adjustment equations.

Basic data with FYM

The difference under FYM and without FYM conditions were very small hence NR and CS were kept constant.

$$\%\,CFYM = \frac{\left(\text{Total uptake of nutrients of control plots with FYM (kg ha}^{-1})\right) - \left(\text{STV of control plots with FYM (kg ha}^{-1}) \times \frac{\%CS}{100}\right)}{\text{Total amount of nutrient added through FYM (kg ha}^{-1})} \times 100 \quad \text{iv)}$$

$$\%\,CF = \frac{\left(\text{Total uptake of nutrients of treated plots with FYM (kg ha}^{-1})\right) - \left(\text{STV of treated plot with FYM (kg ha}^{-1}) \times \frac{\%\,CS}{100}\right) \left(\text{Nutrient added through FYM (kg ha}^{-1}) \times \frac{\%CFYM}{100}\right)}{\text{Fertilizer nutrient added through fertilizer (kg ha}^{-1})} \times 100 \quad \text{v)}$$

$$FN\ (\text{kg ha}^{-1}) = \frac{NRN}{\%\,CF} \times T - \frac{\%\,CS}{\%\,CF} \times STV\ (SN)$$

$$FP_2O_5\ (\text{kg ha}^{-1}) = \frac{NRP}{\%\,CF} \times T - \frac{\%\,CS}{\%\,CF} \times STV\ (SP)$$

$$FK_2O\ (\text{kg ha}^{-1}) = \frac{NRK}{\%\,CF} \times T - \frac{\%\,CS}{\%\,CF} \times STV\ (SK)$$

Fertilizer prescription equation (with FYM)

$$FN\ (kg\ ha^{-1}) = \frac{NRN}{\%\ CF^*} \times T - \frac{\%\ CS}{\%\ CF^*} \times ST\ (N) - \frac{\%\ CFYM}{\%\ CF^*} \times \begin{matrix}\text{Amount of nutrients added through one tone of FYM}\end{matrix} \times FYM\ t\ ha^{-1}$$

$$FP_2O_5\ (kg\ ha^{-1}) = \frac{NRP}{\%\ CF^*} \times T - \frac{\%\ CS}{\%\ CF^*} \times ST\ (P) - \frac{\%\ CFYM}{\%\ CF^*} \times \begin{matrix}\text{Amount of nutrients added through one tone of FYM}\end{matrix} \times FYM\ t\ ha^{-1}$$

$$FK_2O\ (kg\ ha^{-1}) = \frac{NRK}{\%\ CF^*} \times T - \frac{\%\ CS}{\%\ CF^*} \times ST\ (K) - \frac{\%\ CFYM}{\%\ CF^*} \times \begin{matrix}\text{Amount of nutrients added through one tone of FYM}\end{matrix} \times FYM\ t\ ha^{-1}$$

Result and Discussion

The uptake of nitrogen increased from 34.37 kg ha^{-1} in F_0 blocks to 42.31 kg ha^{-1} in F_1 and 47.63 kg ha^{-1} in F_2 blocks, which was increased by and 23.10% and 38% percent over F_0 blocks. The same trend of increase in uptake was observed in control plot. The phosphorus uptake of chickpea was increased as like the nitrogen uptake. The phosphorus uptake increased with increase in the levels of phosphatic fertilizer doses and N and K within the FYM blocks and increased with increasing levels of FYM application. The total P uptake in F_0 blocks was 6.21 kg ha^{-1} which was increased to 7.46 kg ha^{-1} in F_1 and 8.99 kg ha^{-1} in F_2 block depicted in table 2. This indicated the effect of added phosphorus and complementary effect of FYM which two together helped in increasing the uptake of phosphorus with increasing FYM application. The same trend was observed in respect to uptake of K as in N and P by chickpea. The lowest uptake was observed in the control plots and treatment with no K application. The mean total uptake of potassium in treated plots of F_0 blocks was 39.01 kg ha^{-1} which was increased to 48.66 kg ha^{-1} in F_1 and 51.02 kg ha^{-1} in F_2 blocks.

These results indicated an increase in uptake of potassium with increase in levels of potassic fertilizers and FYM application.

The range and mean value of yield, initial soil available nutrients and nutrient uptake of chickpea as influenced by conjoint use of FYM and chemical fertilizer on Inceptisol.

Particular		F_0 (0 t ha^{-1} FYM)		F_1 (5 t ha^{-1} FYM)		F_2 (10 t ha^{-1} FYM)	
		Control	Treated	Control	Treated	Control	Treated
Grain yield (q ha^{-1})	Range	9.30-11.08	17.28-30.11	13.17-17.67	21.42-31.50	20.00-24.08	23.67-33.92
	Average	10.24	23.88	16.11	26.46	22.33	28.40
Straw yield (q ha^{-1})	Range	16.0- 22.8	20.3- 54.9	25.1- 37.9	27.0- 53.8	39.03-42.08	27.39-59.38
	Average	19.7	32.8	30.8	39.4	40.37	40.13
N uptake (kg ha^{-1})	Range	18.72-22.00	24.74-52.98	20.34-24.83	29.89-51.95	30.09-38.66	36.46-67.47
	Average	20.00	34.37	26.92	42.31	33.21	47.63
P uptake (kg ha^{-1})	Range	2.49- 3.33	4.20-10.71	3.03-3.29	5.66- 9.56	3.59-5.22	6.75-13.85
	Average	2.91	6.21	3.14	7.46	4.23	8.99
K uptake (kg ha^{-1})	Range	20.27-24.15	30.91-68.49	28.15-29.06	33.02-60.66	27.65-31.14	36.12-70.58
	Average	21.81	39.01	28.71	48.66	29.67	50.44

The chickpea was taken as test crop in three FYM blocks. FYM blocks were created across the fertility gradients. One F_0 blocks were maintained where no FYM was added F_1 and F_2 blocks where FYM @ 5 t ha^{-1} and 10 t ha^{-1} were added, respectively. In these four FYM blocks 24 NPK treatment combinations including 21 treated and 3 control were randomized across the fertility gradient strips. The conjoint use of FYM and NPK fertilizers in different combinations was carried out in F_1 and F_2 blocks.

An increasing trend with increase in the FYM from 0 to 5 and 10 t ha^{-1}. The chickpea grain yield in treated plots chickpea experiment in the F_0 block, ranged from 9.30 to 30.11 q ha^{-1} depicted in table 2. These results showed that there was an increase in yield with increase in NPK doses, the maximum being with the $N_3P_3K_2$ treatment. The average yield of control plots of both the F_0 blocks was 23.88 q ha^{-1}.

In F_1 FYM block, the same trend of increase in chickpea grain yield was observed with increasing levels of NPK combinations. Due to use of 5 Mg ha^{-1} of FYM along with the NPK treatments, there was an increase in yields ranging from 19.42 to 25.65 q ha^{-1} in treated plots with 26.46 q ha^{-1} average of control plots. The highest yield of 31.50 was observed in $N_3P_2K_3$ treatment, followed by 31.32 q ha^{-1} in $N_3P_3K_3$ treatments. The residual fertility in the L_2 strip and FYM used helped to increase the yields (Anonymous, 1983) [1].

In F_2 i.e. 10 Mg ha^{-1} FYM block the grain yield of chickpea ranged from 20 to 33.92 q ha^{-1} and the mean of control plots was 28.40 q ha^{-1}. There was an increase in yield in control plots in F_2 block than F_0 and F_1 blocks. This shows the beneficial effect of FYM in increasing the yields.

The mean grain yield of treated plots in F_0 blocks was 23.88 q ha^{-1}, in F_1 FYM block 26.46 q ha^{-1} and F_2 block 28.40 q ha^{-1} which shows the additional effect of added FYM in combination with NPK treatments. The yield of control plots of F_1 and F_2 blocks increased by 10 and 18.92 per cent over the yield of control plots of the F_0 block. This has clearly indicated that addition of FYM alone and in combination with NPK fertilizers helped in increasing the chickpea yield.

The data on chickpea yield, soil and fertilizer nutrients from 63 treated plots have been utilized for fitting multiple regression equations based on quadratic function in present investigation.

Yield predictions from soil NPK, fertilizer NPK, FYM and interactions were derived separately from control and treated plots and are given below.

Multiple regression equation for control plots

$Y = 750.73 - 6.76773\ SN + 0.016133\ SN^2 + 5.201983\ SP - 0.17168\ SP^2 - 0.33848\ SK + 0.000417\ SK^2\ R^2 = 0.96$ **

Where, SN, SP, SK are soil available NPK (kg ha^{-1}) in control plots and Y is yield (q ha^{-1}.)

A significant value of coefficient of determination of R^2 (0.96) indicated that the variation in the yield of the control plots significantly depend upon the available nutrient in the soil in the absence of applied fertilizer nutrients.

Multiple regression equation for treated plots

$Y = 78.73 - 0.04438\ FN - 0.00554\ FN^2 - 0.02906\ FP + 0.000514\ FP^2 - 0.07354\ FK + 0.000381\ FK^2 - 0.56623\ SN + 0.00114\ SN^2 - 0.06569\ SP - 0.00191\ SP^2 - 0.04616\ SK - 0.0000299\ SK^2 - 0.002161FN * SN - 0.004105\ FP * SP - 0.000381\ FK * SK\ R^2 = 0.69$**

Where, FN, FP and FK are fertilizer NPK in kg ha^{-1}, SN, SP and SK are soil available NPK kg ha^{-1}, FYM is farm yard manure in t ha^{-1} and Y is chickpea yield in q ha^{-1}.

The data obtained from the equation and the R^2 value, 0.69 indicating 69 per cent variation in chickpea yield obtained by using soil test values, fertilizer dose and FYM. This also suggests a scope for explaining the factors other than the soil test values, fertilizer doses, FYM, which affected the chickpea yield. The R^2 values of 0.69 indicated good fit of these equations. Bangar (1990) [3] reported that the R^2 values for multiple regression equations above 0.66 indicated good fit, 0.65 to 0.45 as moderate fit and below 0.45 as poor fit.

Basic Parameters

The NPK fertilizers were used conjointly with FYM as a source of organic. The nutrient requirement (kg ha^{-1}) through FYM, contribution of N, P and K through FYM (FYM efficiency) and fertilizer adjustments for N, P_2O_5 and K_2O with and without FYM were calculated for chickpea.

Nutrient Requirement (NR)

The data on nutrient requirement of chickpea are reported in table 3. The production of one quintal of chickpea, the nutrient required were 1.52 kg N, 0.26 kg P and 1.72 kg K. Similar results were reported by Jadhav *et al*. (2009) [7]

Per cent contribution from soil (CS %)

The contribution from soil in respect of N for chickpea was 9.32 per cent, for P it was 15.95 per cent and for K it was 6.03 per cent. These results corroborate with the findings of Jadhav *et al*. (2009) [7]

Per cent contribution from fertilizer (without FYM)

The data in respect of per cent contribution of N, P and K from fertilizers for chickpea are presented in Table 3 the per cent contribution of N, P and K fertilizer without FYM were 55.27, 8.10 and 56.61 per cent respectively.

Per cent contribution from fertilizer (with FYM)

The percent contribution of fertilizer with FYM is presented in table 3 the percent contribution of N, P and K fertilizer with FYM in chickpea were 60.60, 9.80 and 64.00 per cent respectively.

Table 3: Basic data for chickpea

S. No	Particular	N	P	K
1	NR (kg q^{-1})	1.52	0.26	1.72
Without FYM				
2	CS (%)	9.32	15.95	6.03
3	CF (%)	55.27	8.10	56.61
With FYM				
4	CFYM (%)	37.7	6.6	32.9
5	CF (%)	60.6	9.8	64.0

Per cent contribution of FYM

The deviations found were only in the contribution from fertilizer. These results are corroborate with the findings made by Gaur *et al.* (1984) [6].

The percent contribution from FYM, the data represented in Table 3 The contribution of N, P and K nutrient through FYM were 37.7, 6.6 and 32.9 per cent respectively. The per cent contribution of P from FYM was quite high, it might be due to 50 percent recovery of FYM in respect of P, the FYM helps in providing more amount of phosphorus through FYM.

Fertilizer prescription equations for yield targeting in chickpea

The basic data on chickpea by using chemical fertilizers with and without FYM were transformed with the help of NR (kg q^{-1}), CS (%), CF (%) and CFYM (%) coefficients into workable fertilizer adjustment equations for different yield targets based on soil test values are given below.

With FYM	Without FYM
FN = 2.51 X T - 0.15 X SN - 3.11 X FYM	FN = 2.75 X T - 0.17 X SN
FP_2O_5 = 2.71 X T - 1.63 X SP - 2.03 X FYM	FP_2O_5 = 3.27 X T - 1.97 X SP
FK_2O = 2.69 X T - 0.09 X SK - 3.09 XFYM	FK_2O = 3.05 X T - 0.11 X SK

Where, FN, FP_2O_5 and K_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, T is yield target in q ha^{-1}, SN,SP and SK are soil available N, P and K in kg ha^{-1} and FYM is Farm Yard manure in t ha^{-1}.

Summary and Conclusion

The chickpea was taken after the maize main experiment for STCRC studies. The nutrient requirement of chickpea by conjoint use of organic manures and chemical fertilizers based on targeted yield approach, the following conclusions can be drawn.

1. The nutrients required to produce one quintal chickpea are 1.52 N, 0.26 P and 1.72 kg K, respectively.

The percent contribution from soil is 9.32, 15.95 and 6.03 per cent for N, P and K, respectively in the sole use of chemical fertilizers per cent contribution from fertilizer is 55.27 per cent for N, 8.10 per cent for P_2O_5 and 56.61 per cent for K_2O and in integrated use of manures and fertilizers the per cent contribution from fertilizers is 60.6 per cent for N, 9.8 per cent for P_2O_5 and 64.0 per cent for K_2O respectively.

2. Equations for sole use of chemical fertilizers and equations for conjoint use of chemical fertilizer and FYM

With FYM	Without FYM
FN = 2.51 X T - 0.15 X SN - 3.11 X FYM	FN = 2.75 X T - 0.17 X SN
FP_2O_5 = 2.71 X T - 1.63 X SP - 2.03 X FYM	FP_2O_5 = 3.27 X T - 1.97 X SP
FK_2O = 2.69 X T - 0.09 X SK - 3.09 X FYM	FK_2O = 3.05 X T - 0.11 X SK

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