Original Research Article

Recalibration of Targeted Yield Equations Through Integrated Plant Nutrition System for Greengram (*Vigna Radiata* L.) on Alfisol

ABSTRACT

In India, greengram (*Vigna radiata* L.) is a popular pulse crop. With the concern for achieving desired yield with ensured soil health, the Soil Test Crop Response (STCR) approach develops the fertilizer prescription equations (FPEs) for the desired yield in greengram by conducting a field experiment on red non-calcareous, sandy loam soil belonging to Palaviduthi soil series (*Typic Rhodustalf)* during rabi 2021-22. The experiment includes 11 treatments viz., Absolute control (T_1), FYM @ 6.25 t ha^{-1} (T_2), 12.5 t ha^{-1} (T_3), STCR-based NPK fertilizer recommendations (STCR-NPK) for the targeted yield of 1.0 (T_4),1.2 (T_5),1.4 t ha^{-1} (T_6), STCR-NPK+FYM @12.5 t ha^{-1} for the targeted yield of 1.0 (T_7),1.2 (T_8),1.4 t ha^{-1} (T_9), Blanket (100% RDF) (T_{10}), Blanket (100% RDF) +FYM @12.5 t ha^{-1} (T_{11}), in Randomized Block Design (RBD) with three replications. The results revealed that a high targeted yield of 1.4 t ha^{-1} T_9 (STCR-NPK+FYM @12.5 t ha^{-1}) was more supercilious than others. Initial soil test values, grain yield, total nutrient uptake, applied fertilizer doses and farmyard manure were used for obtaining four important basic parameters such as nutrients required to produce one quintal grain (NR), contribution of nutrients from soil (%Cs), contribution of nutrients from fertilizer (%Cf), as well as contribution of nutrients from FYM (% Cfym). The nutrient requirement of greengram to produce one quintal of grain yield in terms of N, P_2O_5, and K_2O were 4.76,3.59 and 5.42 kg q^{-1}, respectively. The per cent contribution of nutrients from soil, fertilizer and FYM were 14.00, 48.90 and 34.11 for nitrogen; 36.51,29.59 and 10.24 for phosphorus; and 7.00, 62.65 and 32.12 for potassium, respectively. By using these basic parameters, the fertilizer prescription equations were formulated for greengram in Palaviduthi soil series.

Keywords: Greengram, STCR-IPNS, Targeted yield, Fertilizer Prescription Equations (FPEs).

1. INTRODUCTION

Pulses are extremely significant in Indian agriculture. India is a leading producer of pulses, and they are an essential component of farmer's cropping systems across the country. The most prominent pulse crop being the third largest of all the pulses, Greengram [*Vigna radiata* (L.)] which is commonly known as mungbean belonging to the Leguminosae family revealing a contribution of about 16 per cent of the country's total pulse area. It is a more nutritious, pleasant, digestible, and non-flatulent pulse than other pulses growing around the world. It is high in protein and amino acids, especially lysine (4600 mg g^{-1} N) and tryptophan (60 mg g^{-1} N). Greengram seeds are also taken because they are rich in ascorbic acid (vitamin C), riboflavin, thiamine and 60 % carbohydrate, 23.9 % protein, 4% minerals, and 3% vitamin [1]. Greengram is grown on 4.5 million hectares in India, yielding 2.5 MT with average productivity of 548 kg ha^{-1}. In Tamil Nadu, Greengram has a 0.17 million hectare area, produces 0.07MT and has a productivity of 445 kg ha^{-1} under irrigation conditions in 2019-2020 [2].

The rising demand for food security urged the farmers to produce more per unit area of land which made them go for excessive use of chemical fertilizers which had a negative impact on soil and environment. This imbalanced fertilization necessitates the need for an efficient site-specific nutrient approach with the main consideration of soil fertility. The most appropriate way for determining the best fertilizer dosages is to apply fertilizer based on soil tests and crop response research. Among the several approaches, the targeted yield approach has been found popular in India [3,4]. The targeted yield strategy is used to create a relationship between crop yields on one part and soil test values and fertilizer inputs on the other. The targeted yield concept is based on a quantitative conception of fertilizer demands based on crop yield and nutritional requirements, as well as the percentage contribution of soil available nutrients and fertilizers [5]. This technique estimates not only the soil test based fertilizer dose but also the amount of yield that a farmer may obtain with that dose [6].

The fertilizer application practices based on a targeted yield approach indicated the possibility of enhancing production potentials of greengram. Along with the sustenance of soil fertility and balanced fertilization of the crops. this can also help the farmers in achieving the desired targeted yield. The efficacy of STCR approach can be improved by including the application of organic manures as STCR-IPNS approach which may facilitate the continuous and need based nutrient application to the crops without having a harmful impact on both soil and environment. Hence, the present study was

under taken to develop a balanced fertilizer schedule with or without FYM application for desired yield targets of greengram on palaviduthi soil series.

2. MATERIAL AND METHODS

2.1 Experiment location and initial soil description

A soil test crop response (STCR) correlation study on Greengram (Var. Co 8) was conducted during rabi 2021-22 on an alfisol at a farmer's holding in Thondamuthur block, Coimbatore district. The experimental field's soil belongs to the Palaviduthi soil series (*Typic Rhodustalf*). The initial soil samples before commencing the experiment were collected and analyzed for their physical, physiochemical, and chemical parameters. The results of the initial soil analysis showed the soil is red, non-calcareous, sandy loam, slightly alkaline (pH-7.80), non-saline (EC-0.11 dS m^{-1}), medium organic carbon (0.57 g kg^{-1}) and high available $KMnO_4$-N (308 kg ha^{-1}), Olsen-P (28 kg ha^{-1}) and NH_4OAc-K (410 kg ha^{-1}) respectively. The soil is sufficient in available micronutrients Cu, Mn, Fe, and Zn.

2.2 Treatment details

The experiment was laid out in Randomized Block Design (RBD) with three replications of eleven treatments. Viz., T_1: Absolute control, T_2: Farmyard manure (FYM) alone @ 6.25 t ha^{-1}, T_3: FYM alone @12.5 t ha^{-1}, T_4: STCR-NPK alone -1.0 t ha^{-1}, T_5: STCR-NPK alone - 1.2 t ha^{-1}, T_6: STCR-NPK alone - 1.4 t ha^{-1}, T_7: STCR-IPNS -1.0 t ha^{-1}, T_8: STCR-IPNS - 1.2 t ha^{-1}, T_9: STCR-IPNS -1.4 t ha^{-1}, T_{10}: Blanket (100 % Recommended Dose of Fertilizers (RDF), T_{11}: Blanket (100% RDF) + FYM @ 12.5 t ha^{-1}. Based on the initial soil test data of available N, P and K and the amounts of N, P_2O_5 and K_2O provided through FYM, fertilizer doses were calculated by using existing Fertilizer Prescription Equations FPEs (Irugur soil series) and applied for STCR, treatments for various yield targets.

2.3 Experimental methodology

Before starting the experiments, the soil was collected, processed, and evaluated for available N [7], P [8], and K [9] using the usual protocols, respectively. The existing fertilizer prescription equations for greengram on the Irugur series developed for the conventional method of soil application under STCR-NPK alone were used to develop equations Palaviduthi series under STCR-NPK alone and STCR-IPNS. which were given below:

Existing Fertilizer Prescription Equations for greengram under STCR on Irugur series

STCR-NPK Alone
FN = 25.07 T - 0.71 SN
FP_2O_5 = 15.44 T - 5.48 SP
FK_2O = 11.00 T - 0.19 SK

Farmyard manure (FYM) was administered at a rate of 12.5 t ha^{-1} for IPNS treatments, (24% moisture, 0.52, 0.32, 0.51 % N, P, K) respectively. Depending on the treatments, urea (46 per cent N), single super phosphate (16 per cent P_2O_5), and muriate of potash (60 per cent K_2O) were used to compute the nutritional dosage. Basally, the entire dosage of N, P_2O_5, and K_2O was given.

Greengram was used as a test crop, and the complete set of techniques was carried out in accordance with the TNAU Crop Production Guide (Agriculture), 2020 [10]. During the harvesting stage, grain and haulm yields from each plot were recorded. These samples were processed and tested for N [11], P, and K content [12]. The nutrient uptake of grain and haulm was calculated by multiplying the grain and haulm yield by its corresponding nutrient content.

Fertilizer prescription equations were established based on experimental data on grain yield, nutrient uptake, initial soil available N, P, K, and fertilizer dosages supplied in (Table 3) for greengram by refining the existing FPEs using the AICRP - STCR procedure on Soil Test Crop Response Correlation. These data were statistically examined with AGRES software version 7.01. $P< 0.05$ was utilized as the level of significance. When the "F" test was significant, critical difference (CD) values were calculated for the $P < 0.05$ [13]. The data obtained from treatments, T_1 to T_9 were utilized for developing FPEs. The fundamental parameters were calculated using the methodology given by Ramamoorthy and co-workers, [14] as follows:

1. Nutrient requimpent (NR in kg q^{-1})

i) kg N required per quintal of grain production = $\frac{\text{Total uptake of N (kg ha}^{-1})}{\text{Grain yield (q ha}^{-1})}$

ii) kg P_2O_5 required per quintal of grain production = $\frac{\text{Total uptake of } P_2O_5 \text{ (kg ha}^{-1})}{}$

$$\text{Grain yield (q ha}^{-1}\text{)}$$

iii) kg K_2O required per quintal of grain production = $\dfrac{\text{Total uptake of } K_2O \text{ (kg ha}^{-1}\text{)}}{\text{Grain yield (q ha}^{-1}\text{)}}$

2. Per cent contribution of nutrients from soil to total nutrient uptake (C_s)

i) Per cent contribution of N from soil = $\dfrac{\text{Total uptake of N in control plot (kg ha}^{-1}\text{)}}{\text{Soil test value for available N in control plot (kg ha}^{-1}\text{)}} \times 100$

ii) Per cent contribution of P_2O_5 from soil = $\dfrac{\text{Total uptake of } P_2O_5 \text{ in control plot (kg ha}^{-1}\text{)}}{\text{Soil test value for available } P_2O_5 \text{ in control plot (kg ha}^{-1}\text{)}} \times 100$

iii) Per cent contribution of K_2O from soil = $\dfrac{\text{Total uptake of } K_2O \text{ in control plot (kg ha}^{-1}\text{)}}{\text{Soil test value for available } K_2O \text{ in control plot (kg ha}^{-1}\text{)}} \times 100$

3.Per cent contribution of nutrients from fertilizers to total uptake (C_f)

i) Per cent contribution of N from fertilizer = $\dfrac{\text{Total uptake of N in treated plot (kg ha}^{-1}\text{)} - \left(\text{Soil test value for available N in treated plot (kg ha}^{-1}\text{)} \times \text{Average Cs}\right)}{\text{Fertilizer N applied (kg ha}^{-1}\text{)}} \times 100$

ii) Per cent contribution of P_2O_5 from fertilizer = $\dfrac{\text{Total uptake of } P_2O_5 \text{ in treated plot (kg ha}^{-1}\text{)} - \left(\text{Soil test value for available } P_2O_5 \text{ in treated plot (kg ha}^{-1}\text{)} \times \text{Average Cs}\right)}{\text{Fertilizer } P_2O_5 \text{ applied (kg ha}^{-1}\text{)}} \times 100$

iii) Per cent contribution of K_2O from fertilizer

$$= \frac{\text{Total uptake of } K_2O \text{ in treated plot (kg ha}^{-1}) - \left(\text{Soil test value for available } K_2O \text{ in treated plot (kg ha}^{-1}) \times \text{Average Cs}\right)}{\text{Fertilizer } K_2O \text{ applied (kg ha}^{-1})} \times 100$$

4.Per cent nutrient contribution of nutrients from organics to total uptake (Cfym)

$$\text{Cfym} = \frac{\text{Total uptake of N/P/K in FYM treated plot (kg ha}^{-1}) - \left(\text{Soil test value for available N/P/K in FYM treated plot (kg ha}^{-1}) \times \text{Average Cs}\right)}{\text{Nutrient N/P/K added through FYM (kg ha}^{-1})} \times 100$$

Fertilizer Prescription Equations

The Fertilizer Prescription Equations for greengram were developed using the computed basic parameters and could be used to calculate the required dose of fertilizer for a particular soil test value on Palaviduthi soil series. The FPEs were created in the following methods:

i) Fertilizer nitrogen (FN)

$$FN = \frac{NR}{Cf/100} \times T - \frac{Cs}{Cf} \times SN$$

$$FN = \frac{NR}{Cf/100} \times T - \frac{Cs}{Cf} \times SN - \frac{Cfym}{Cf} \times ON$$

ii) Fertilizer phosphorus (FP_2O_5)

$$FP_2O_5 = \frac{NR}{Cf/100} \times T - \frac{Cs}{Cf} \times 2.29 \times SP$$

$$FP_2O_5 = \frac{NR}{Cf/100} \times T - \frac{Cs}{Cf} \times 2.29 \times SP - \frac{Cfym}{Cf} \times 2.29 \times OP$$

iii) Fertilizer potassium (FK_2O)

$$FK_2O = \frac{NR}{Cf/100} \times T - \frac{Cs}{Cf} \times 1.21 \times SK$$

$$FK_2O = \frac{NR}{Cf/100} \times T - \frac{Cs}{Cf} \times 1.21 \times SK - \frac{Cfym}{Cf} \times 1.21 \times OK$$

where, FN, FP_2O_5 and FK_2O are fertilizers N, P_2O_5 and K_2O in kg ha^{-1}, respectively; NR is nutrient requirement of N, P_2O_5 and K_2O (kg q^{-1}), Cs is the per cent contribution of nutrients from soil, Cf is per cent contribution of nutrients from fertilizer, Co is per cent contribution of nutrients through organics (fym).T: grain yield target in q ha^{-1}; SN, SP and SK are available N, P and K through soil in kg ha^{-1}. ON, OP and OK are N, P and K supplied through fym in kg ha^{-1} respectively.

3.RESULTS AND DISCUSSION

3.1 Grain yield

It is evidence from the data depicted in Table3 that the grain yield ranged from 690 to 1293 kg ha^{-1} due to different treatment imposition. Among the various treatments, the maximum grain yield of 1293 kg ha^{-1} was recorded in T_9: STCR-NPK + FYM @ 12.5 t ha^{-1} followed by T_6: STCR-NPK alone with the yield of 1204 kg ha^{-1}. A higher yield was recorded in STCR-IPNS than in STCR-NPK alone. This finding was in accordance with the results given for Pigeon-pea [6] and pea [15]. The grain yield in T_8 (1231 kg ha^{-1}), T_5 (1142 kg ha^{-1}), T_{11} (1078 kg ha^{-1}), T_7 (1107 kg ha^{-1}), T_4 (1057 kg ha^{-1}), and T_{10} (936 kg ha^{-1}) was found to be less than the grain yield recorded in treatments T_9 (1293 kg ha^{-1}) and T_6 (1204 kg ha^{-1}). This specified superiority of STCR-IPNS over STCR-NPK alone was also reported by [16]. The lowest grain yield recorded in NPK alone treatments might be due to the solo application of NPK fertilizer requiring some additional essential nutrients that would be available in organic manures [17]. Moreover, there was synchronism in nutrient release and plant recovery resulting in enhanced yield and improved soil properties in STCR-IPNS [18]. All fertilization treatments exceeded the organic alone treatments Viz., T_2: FYM alone @ 6.25 t ha^{-1} (784 kg ha^{-1}) and T_3: FYM alone @ 12.5 t ha^{-1} (805 kg ha^{-1}) respectively. Grain yield was found to be minimum in T_1: Absolute control with a yield of 690 kg ha^{-1}. These results are similar to those reported by greengram on Inceptisols of Odisha [19].

3.2 Nutrient uptake

The nutrient uptake was found to be directly proportional to grain yield. The N, P and K uptake ranged from 41.86 to 58.18 kg ha^{-1}, 10.37 to 21.71 kg ha^{-1}, and 28.03 to 37.58 kg ha^{-1} respectively (Table 3). The N, P and K uptake were also reported to be maximum in T_9: STCR-NPK + FYM @ 12.5 t $ha^{-1}$with 58.18, 21.71 and 57.99 kg ha^{-1} followed by T_6: STCR- NPK alone with total NPK uptake of 57.17, 20.04 and 56.12 kg ha^{-1} respectively. This nutrient uptake pattern matched exactly the studies on STCR-IPNS based fertilizer prescriptions in pearl millet given by [20]. Among the treatments T_8, T_5, and T_{11} were comparable to T_9 and T_6 in terms of N uptake of 56.23, 55.17, and 54.84 kg ha^{-1}, P uptake of 18.28, 17.59, and 16.95 kg ha^{-1}, and K uptake of 57.99, 53.03, and 52.45 kg ha^{-1}. The treatments T_7, T_4, and T_{10} uptake had 54.26, 53.25, and 53.89 kg N ha^{-1}, 16.76, 15.46, and 15.85 kg P ha^{-1}, and 51.28, 49.12, and 50.31 kg K ha^{-1}, respectively and found to be lesser than treatments T_9 and T_6. This indicated the superiority of grain yield in STCR-IPNS over STCR-NPK alone which is analogous to the uptake in Bhendi given by [21] and Pearl millet [22]. All the fertilized treatments were superior than FYM alone @ 6.25 t ha^{-1} and 12.5 t ha^{-1} which recorded 51.35 and 52.45 kg N uptake ha^{-1}, 12.24 and 13.52 kg P uptake ha^{-1}, and 37.58 and 39.54 kg K uptake ha^{-1} respectively. The increasing N, P and K uptake were due to a combination of organic and inorganic fertilizer compared to chemical fertilizers [23]. This reason shows that significant use of organic residue, produces intermediate acids during the decomposition of organic residues and solubilizes the fixed form of N and P in soil, which leads to increased uptake of N and P in greengram [24]. The lowest NPK uptake was under T_1(absolute control), with values of 41.86, 10.37, and 28.03 kg per ha^{-1}, respectively. This pattern of nutrient uptake matched similarly with the research findings of barnyard millet [25], cassava [26], greengram [27] and rice [28].

3.3 Response

The response of fertilizers to grain yield was delineated from the experiment which was found to be ranging from 94 to 603 kg ha^{-1} (Table 3). Maximum response of 603 t ha^{-1} was attained in T_9 (STCR-NPK + FYM @ 12.5 t ha^{-1}) than T_6: STCR- NPK alone (514 kg ha^{-1}) and T_3 low response (115 kg ha^{-1}) were observed in FYM alone @ 12.5 t ha^{-1}. When the targeted yield increases relatively response also increases. While comparing STCR-NPK alone treatments of the same yield targets with STCR-IPNS treatments, the response was observed to be larger in STCR-IPNS due to the combined use of inorganic and organic

fertilizers produced a larger response than inorganic fertilizers alone. The current trend was also exposed in maize given by Mohanapriya and other co-workers [29].

3.4 Basic parameters

The basic parameters viz., nutrient requirement (NR), percentage contribution from soil (Cs), fertilizer (Cf) and FYM (Cfym) were computed and have been calculated as described by [30,31] and presented in Table 1. These basic parameters were used for formulating the fertilizer prescription equations under NPK alone and along with FYM (12.5 t ha^{-1}). The nutrient requirements per quintal of greengram grain were computed as 4.76, 3.59, and 5.42 kg of N, P_2O_5 and K_2O, respectively. The K_2O requirement was higher subsequently followed by N and P_2O_5. The order of greengram nutrient requirement was in accordance with the results of [32] for cowpea. The percentage of contributions nutrients from soil to total nutrient uptake was estimated from absolute control and it was 14.00 for N, 36.51 for P_2O_5, and 7.00 for K_2O. The per cent contribution of P_2O_5 from soil was higher compared to N and K_2O which is similar to the findings of [33] on Urd. The per cent contribution of nutrients from fertilizer to total nutrient uptake was estimated from NPK alone, NPK-FYM treated plots. The values were found to be 48.90 for N, 29.59 for P_2O_5, and 62.65 for K_2O. The per cent contribution of K_2O from fertilizer was higher followed by N and P_2O_5. The sequence of K_2O > N > P_2O_5 was shown by the data on C_f in a similar pattern followed by Sugumari and co-workers [34]. Accordingly, the FYM supplied 34.11, 10.24, and 32.12 per cent of N, P_2O_5, and K_2O, respectively. This trend was in synchronous with the results of tomato [35] and cauliflower [36].

Table 1: Basic parameters computed for greengram to develop FPEs under palavidhuthi soil series

Parameters	N	P_2O_5	K_2O
NR (kg q^{-1})	4.76	3.59	5.42
Cs (%)	14.00	36.51	7.00
Cf (%)	48.90	29.59	62.65
Co (%)-FYM	34.11	10.24	32.12

3.5 Fertilizer Prescription Equations for greengram under *Typic Rhodustalf*

The fundamental parameters NR, Cs, Cf, and Cfym are used to generate fertilizer prescription equations under STCR - NPK alone and STCR - IPNS for greengram.

Table 2. Fertilizer prescription equations for greengram under STCR-IPNS

STCR-NPK	STCR-NPK +FYM
FN = 9.74 T - 0.29 SN	FN = 9.74 T - 0.29 SN - 0.70 ON
FP_2O_5 = 12.14 T - 2.83 SP	FP_2O_5 = 12.14 T - 2.83 SP - 0.79 OP
FK_2O = 8.65 T - 0.14 SK	FK_2O = 8.65 T - 0.14 SK - 0.62 OK

Where, FN, FP_2O_5 and FK_2O are fertilizers N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T: Grain yield target in q ha^{-1}; SN, SP and SK are available N, P and K through soil in kg ha^{-1}, respectively; ON, OP and OK are N, P and K supplied through FYM in kg ha^{-1}.

3.5 Soil test-based Fertilizer Recommendations for Greengram

As discussed earlier the STCR-IPNS based on fertilizer prescription equations were developed for greengram on palavidhuthi soil series (Table 2) on the basic equations, a ready reckoner was prepared for a range of soil test data and greengram grain yield target of 1.0,1.2,1.4 t ha^{-1} and give in Table 4.

The ready reckoner of fertilizer prescriptions for greengram was formulated exploiting the constructed FPEs for a range of soil test values and desired yield targets of 1.0, 1.2, and 1.4 t ha^{-1}. An estimate from these data showed that fertilizer N doses required for the soil with 308 kg ha^{-1} of available N in order to produce 1.0, 1.2 and 1.4 t ha^{-1} were 12.5*, 28 and 37.5** kg ha^{-1}. When 28 kg ha^{-1} of available P was estimated in the soil, the amount of fertilizer P_2O_5 needed was 42, 66 and 75** kg ha^{-1} for achieving the targeted yield of 1.0, 1.2 and 1.4 t ha^{-1}. Correspondingly, 29, 37.5**and 37.5** kg ha^{-1} of fertilizer K_2O were prescribed for the soil having 410 kg ha^{-1} of available K to produce the yield of 1.0, 1.2 and 1.4 t ha^{-1}.

By availing of the developed FPEs, the fertilizer doses were stipulated for an array of soil test values with the prime intention of reaching the targeted yield of 1.0, 1.2 and 1.4 t ha^{-1}. When FYM @ 12.5 t ha^{-1} with the moisture of 24 per cent and nutrient content of 0.52, 0.36 and 0.51 per cent of N, P, K respectively was applied together with NPK alone, fertilizer saving was asserted to be 34, 24 and 30 kg of N, P_2O_5, K_2O ha^{-1}. Similar findings have been reported in pigeon pea [6], vegetable cowpea [32], onion [37] and maize [38].

Table 3. Range and mean of grain yield, Initial soil test values, NPK uptake, and response in Greengram

TREATMENT	Grain Yield	UN	UP	UK	SN	SP	SK	FN	FP_2O_5	FK_2O	FYM	Response
	(kg ha^{-1})										t ha^{-1}	kg ha^{-1}
T_1 Absolute control	690	41.86	10.37	28.03	299	28.43	400	0	0	0	0	
T_2 FYM alone @ 6.25 t ha^{-1}	784	51.35	12.24	37.58	298	29.32	398	0	0	0	6.25	94
T_3 FYM alone @ 12.5 t ha^{-1}	805	52.45	13.52	39.54	298	28.41	398	0	0	0	12.5	115
T_4 STCR - NPK alone - 1.0 t ha^{-1}	1057	53.25	15.46	49.12	308	30.27	398	12.5*	25*	32	0	367
T_5 STCR - NPK alone - 1.2 t ha^{-1}	1142	55.17	17.59	53.03	306	30.33	399	21	32	54	0	452
T_6 STCR - NPK alone-1.4 t ha^{-1}	1204	57.17	20.04	56.12	304	31.19	400	71	63	76	0	514
T_7 STCR-IPNS - 1.0 t ha^{-1}	1107	54.26	16.76	51.28	308	31.42	398	12.5*	25*	32	12.5	417
T_8 STCR-IPNS - 1.2 t ha^{-1}	1231	56.23	18.28	54.29	307	32.19	399	21	32	54	12.5	541
T_9 STCR-IPNS - 1.4 t ha^{-1}	1293	58.18	21.71	57.99	305	32.22	400	71	63	76	12.5	603
T_{10} Blanket (100% RDF)	936	53.89	15.85	50.31	304	29.33	401	25	50	25	0	246
T_{11} Blanket (100% RDF)+ FYM @12.5 t ha^{-1}	1078	54.84	16.95	52.45	303	29.12	404	25	50	25	12.5	388
Range	690-1293	41.86-58.18	10.37-21.71	28.03 - 57.99	298 - 308	28.41-32.22	398 - 404					
Mean	1030	54	16	48	304	30	400					
CD (0.05)	56.14	2.25	0.64	2.87								
Sed	27.04	1.08	0.31	1.37								

*Where: UN-Uptake of nitrogen (kg ha^{-1}), UP-Uptake of Phosphorus (kg ha^{-1}), UK-Uptake of potassium (kg ha^{-1}), * maintenance dose*

Table 4: Soil test-based fertilizer recommendations (FN, FP_2O_5, FK_2O in kg ha^{-1}) for Greengram under STCR – NPK alone and STCR – IPNS

Soil Test Value (kg ha^{-1})	NPK alone			NPK-IPNS			% Reduction due to IPNS over STCR-NPK alone		
	Yield target (t ha^{-1})								
	1.0	1.2	1.4	1.0	1.2	1.4	1.0	1.2	1.4
$KMnO_4$ – N	**FN**								
270	19	37.5**	37.5**	12.5*	12.5*	24	34	67	36
280	16	36	37.5**	12.5*	12.5*	21	22	65	44
290	13	33	37.5**	12.5*	12.5*	18	4	62	52
300	12.5*	30	37.5**	12.5*	12.5*	15	0	58	60
310	12.5*	27	37.5**	12.5*	12.5*	13	0	54	65
320	12.5*	24	37.5**	12.5*	12.5*	12.5*	0	48	67
Olsen – P	**FP_2O_5**								
22	59	75**	75**	35	60	75**	41	20	0
24	53	75**	75**	30	54	75**	43	28	0
26	48	72	75**	24	48	73	50	33	3
28	42	66	75**	25*	43	67	40	35	11
30	37	61	75**	25*	37	61	32	39	19
32	31	55	75**	25*	31	56	19	44	25
NH_4OAc – K	**FK_2O**								
380	33	37.5**	37.5**	12.5*	21	37.5**	62	44	0
390	32	37.5**	37.5**	12.5*	19	37.5**	61	49	1
400	31	37.5**	37.5**	12.5*	18	35	60	52	7
410	29	37.5**	37.5**	12.5*	17	34	57	55	9
420	28	37.5**	37.5**	12.5*	15	33	55	60	12
430	26	37.5**	37.5**	12.5*	14	31	52	63	17

(**maintenance dose; ***maximum dose*)

- Blanket dose for greengram: 25:50:25 kg of N, P_2O_5, and K_2O ha^{-1}.
- If the estimated fertilizer dose frequently decreases below 50% of the blanket, a maintenance dose of 50% of the blanket is suggested.
- A maximum dose of 150% of the blanket is advised for N, P_2O_5, and K_2O, respectively, if the calculated dose is more than 150% of the blanket.

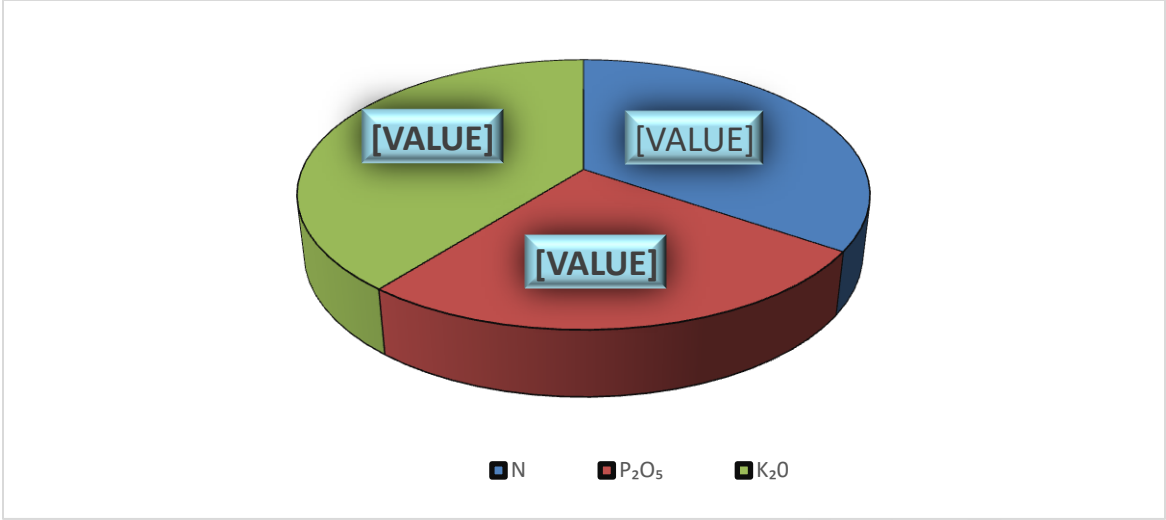

Fig1. Nutrient Requirement (NR- kg q^{-1})

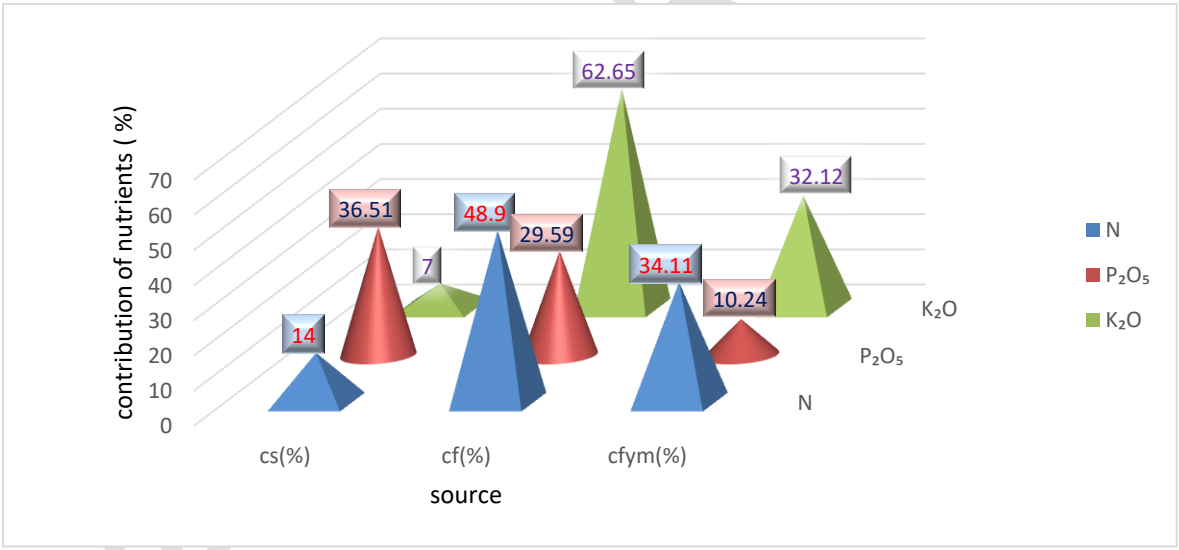

Fig 2. Contribution of nutrients from soil (Cs %), fertilizer (Cf%), and (Cfym%)

4. CONCLUSION

In the present investigation, the Soil Test-based Integrated Plant Nutrition System for greengram has been developed on *Typic Rhodustalf* (red, non-calcareous, Palaviduthi soil series) of Tamil Nadu. The preceding result exposed the targeted yield perception that could be efficiently implemented to carry in site-specificity in fertilizer practice and attain maximum yields of greengram on alfisol. Also, the fertilizer application rates will be subsequently curtailed with conjoint use of fertilizers and organic manure. In generally, integrated application of FYM and inorganic fertilizer should be applied together to increase soil productivity and health rather than the use of inorganic fertilizer alone. Target yield equations generated from STCR-IPNS expertise ensure not only sustainable crop production but also economic use of expensive fertilizer.

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