International Journal of Plant & Soil Science

34(20): 473-484, 2022; Article no.IJPSS.88669
ISSN: 2320-7035

Soil Test based Targeted yield equations for blackgram (*Vigna mungo* L.) through Integrated Plant Nutrition System on *Alfisol*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2031178

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/88669

Original Research Article

Received 20 April 2022
Accepted 23 June 2022
Published 25 June 2022

ABSTRACT

Using Ramamoorthy's inductive methodology for assessing the soil test based crop requirement by adopting an Integrated Plant Nutrition System to create Fertilizer Prescription Equations (FPEs) for blackgram with the prime objective of attaining the targeted yield by the farmers. A field experiment was conducted out on red non-calcareous sandy loam soil belonging to the Palaviduthi soil series (*Typic Rhodustalf*) during rabi 2021-22. The experiment comprised of eleven treatments *viz*., STCR - NPK alone and STCR - IPNS for yield targets 1.0,1.2,and 1.4 t ha^{-1}, Blanket (25:50:25) @ 100% with and without FYM (12.5 t ha^{-1}), FYM alone @ 6.25 and 12.5 t ha^{-1} and absolute control in randomized block design with three replications. From the experimental data, basic parameters *viz*., nutrient requirement (NR), per cent contribution from soil (Cs), per cent contribution from fertilizers (Cf), and per cent contribution from FYM (Cfym) were computed. The quantity of fertilizers contributed by the application of Farmyard manure was assessed. It has been found that the nutrient requirement for producing one quintal grain of blackgram was 4.77 kg of N, 4.50 kg of P_2O_5, and 5.05 kg of K_2O. The per cent contribution from soil (Cs) was 15.61, 29.91, and 8.12 for N, P, and K respectively and the percent contribution from fertilizers (Cf) and FYM (Cfym) was 48.61 and

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37.19 for N, 44.78, and 14.63 for P_2O_5 and 55.72 and 31.71 for K_2O**.** FPEs for blackgram were generated using these basic parameters through a Soil Test Crop Response based Integrated Plant Nutrition System (STCR-IPNS). Fertilizer Prescription Equations (FPEs) created in this mode were used to create nomograms for a range of soil test values and yield targets. Thus the Inductive cum Targeted Yield Model used to develop fertilizer prescription equations provides a strong basis for soil nutrient maintenance consistent with high productivity and efficient nutrient management in farming for sustainable and enduring agriculture.

Keywords: Blackgram; farmyard manure; soil test crop response; fertilizer prescription equations (FPEs).

1. INTRODUCTION

Blackgram (*Vigna mungo L.*) is a highly lucrative legume crop that was introduced from India and is now cultivated throughout Southern Asia. In a poor man's diet, it is the cheapest source of plant protein. Blackgram, which comprises nearly 24% protein, 60% carbohydrates, fat, minerals, and amino acids like methionine and cysteine, is thought to be of great importance in terms of food,energy, and nutritional security. It generates 10% of India's total pulse production [1]. To increase the output of blackgram, proper fertilization is required.

“Fertilizer is one of the most expensive agricultural inputs, and getting the appropriate amount is critical for farm profitability and environmental protection” [2].”The low productivity in this crop is attributed to its narrow genetic base, poor plant type, vulnerability to abiotic and biotic stresses and cultivation in the marginal and harsh environments” [3] and inadequate use of micronutrients [4,5].It serves also as cover crop and improves soil fertility by fixing atmospheric nitrogen. “For increased productivity, a well-balanced diet is essential. Simultaneously, in order to meet rising nutrient demand, there is an urgent need to explore alternative nutrient sources, such as organic manures and bio-fertilizers for long-term productivity and more ecologically friendly nutrient management methods.In this context, neither do the organic manures fulfill the crop nutrient requirement nor do the chemical fertilizers maintain and restore the physical, chemical and biological health of the soils for sustainable agriculture. Therefore, there is a need for standardizing the mixed use of organic and inorganic sources of nutrients to increase the productivity of crops and improve the soil health” [6].

“Soil test based fertilizer application is a useful tool and it is presumed that a fertilizer prescription equation is a unique technology to optimize need-based fertilizer application. The concept of fertilizer prescription equations for desired yield target was first given by Truog” [7]. “Later on Ramamoorthy and his co-authors established theoretical basis and experimental technique to suit Indian soil and climatic conditions showing the linear relationship between yield and nutrient uptake” [8]. For a given quantity of yield of any crop, fertilizer requirement can be estimated considering efficiency of soil and fertilizer nutrients.

The desire for higher yield had driven the farmers to apply excessive quantities of fertilizers by ignoring the soil nutrient status and crop nutritional requirements that had a negative impact on soil health. On the other hand, blanket recommendations pose some limitations due to variation in inherent soil fertility in varying locations which may result in either in adequacy or toxicity of nutrients while the desired yield will not be achieved. To preserve soil from the negative impacts, the Soil Test Crop Response approach is a more sustainable approach, not only by providing balanced fertilizer recommendations but also by aiding farmers in achieving their targeted yield. Hence an attempt was made to refine develop fertilizer prescription equations for blackgram through STCR – IPNS approach for desired yield in red non-calcareous soil (Palaviduthi series).

2. MATERIALS AND METHODS

2.1 Soil Characteristics and Experimental Description

A field experimental study was conducted in Thondamuthur Block, Coimbatore during the rabi season of 2021-2022. Using the experimental crop blackgram(VBN8), the soil belongs to the Palaviduthi soil series (red non-calcareous). The experimental field's surface soil (0-15 cm) was red non-calcareous, sandy loam texture with slightly alkaline pH (7.91),non- saline (electrical conductivity (EC)) of 0.12 dSm^{-1}), loworganic carbon (0.42 %), low available N (220 kg ha^{-1}), high available P (62 kg ha^{-1}) and available K (332 kg ha^{-1}) respectively; and sufficient in the following micronutrients Cu, Mn, Fe, and Zn. On a plot size of 5 x 4 m^2, the experiment was laid out in randomized block design (RBD) with eleven treatment combinations and three replications. Hand-dibbled blackgram seeds were placed 30 x 10 cm apart and covered with soil.Urea (46 percent N), single super phosphate (SSP, 16 percent P_2O_5), and muriate of potash (MOP, 60 percent K_2O) were employed as sources of nitrogen, phosphorus, and potassium in the treatment (T_4 to T_{11}) as a basal application.

2.2 Treatments

The treatments were,

	Treatments
T_1	Absolute control
T_2	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% RDF)
T_{11}	Blanket (100% RDF)+ FYM @12.5 t ha^{-1}

(FYM: Farmyard manure, RDF: Recommended dose of Fertilizers)

By using these eleven treatments and three replications, the study was set up in randomized block design.The entire amount of Urea,SSP and MOP was given basally along with FYM as organic source for the particulate treatments[9].

2.3 Soil and Plant Analysis

"The soil samples were collected antecedent to fertilizer and manure application and analyzed for alkaline $KMnO_4$-N" [10], Olsen-P [11] and NH_4OAc-K [12]."The grain and haulm yields were noted for different treatments and samples were collected and analyzed for total N [13], total P and total K" [14]. "The total N, P and K uptake for different treatments were calculated by taking into account the dry matter yield and N, P and K content in the grain and haulm of blackgram. The impact of the treatments imposed on yield and uptake was investigated using statistical analysis of the experimental data using AGRES software version 7.01. The level of significance used was $P < 0.05$. Critical difference (CD) values were calculated for the $P < 0.05$ whenever "F" test was found significant"[15].

2.4 Trial Methodology

The required parameters for formulating fertilizer prescription equations for targeted yield were experimentally obtained for a given soil type-crop-agroclimatic condition. All of the practices were followed according to the TNAU Crop Production Guide 2020[9]. In addition to the calculated fertilizer doses from the existing FPEs, for STCR – IPNS, FYM alone and blanket + FYM @12.5 t ha^{-1}treatments, FYM (with 24% moisture 0.54% N, 0.26% P and 0.51% K) was applied as per the treatment schedule. Before commencing the field experiment, the soil samples were taken from each plot. Chemical characteristics and available macronutrients were examined in initial soil samples.From the experimental data on grain and haulm yields, nutrient uptake, initial soil available N,P and K and fertilizer dose added (Table 1) were reported. By use of this data fertilizer prescription equations were developed for blackgram by refinement of existing FPEs.

The basic parameters *viz*., nutrient requirement (NR), per cent contribution from soil (Cs),per cent contribution from fertilizer (Cf) and per cent contribution from FYM were determined following theprocedure reported earlier by [8]. The available soil nutrientcontent is considered while estimating the contribution from soil, fertilizer and FYM. The formulae for computing the basic parameters are furnished below:

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

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

ii) Kg P_2O_5 required per quintal of grain production $= \dfrac{\text{Total uptake of } P_2O_5 \text{ (kg ha}^{-1})}{\text{Grain yield (q ha}^{-1})}$

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

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

i) Per cent contribution of N from soil

$$= \frac{\text{Total uptake of N in control plot (kg ha}^{-1}\text{)}}{\text{Soil test value for available N in control plot (kg ha}^{-1}\text{)}} \times 100$$

ii) Per cent contribution of P_2O_5 from soil

$$= \frac{\text{Total uptake of } P_2O_5 \text{ in control plot (kg ha}^{-1}\text{)}}{\text{Soil test value for available } P_2O_5 \text{ in control plot (kg ha}^{-1}\text{)}} \times 100$$

iii) Per cent contribution of K_2O from soil

$$= \frac{\text{Total uptake of } K_2O \text{ in control plot (kg ha}^{-1}\text{)}}{\text{Soil test value for available } K_2O \text{ in control plot (kg ha}^{-1}\text{)}} \times 100$$

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

i) Per cent contribution of N from fertilizer

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

ii) Per cent contribution of P_2O_5 from fertilizer

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

iii) Per cent contribution of K_2O from fertilizer

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

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

i) Per cent contribution from FYM (Cfym)

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

Fertilizer prescription equation

Making use of these basic parameters, the FPEs will be developed as follows:

i) Fertilizer nitrogen (FN)

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

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

ii) Fertilizer phosphorus (FP_2O_5)

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

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

iii) Fertilizer potassium (FK_2O)

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

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

Where, FN: Fertilizer N (kg ha^{-1}); FP_2O_5: Fertilizer P_2O_5 (kg ha^{-1}); FK_2O: Fertilizer K_2O (kg ha^{-1}); NR: Nutrient requirement of N or P_2O_5 or K_2O (kg q^{-1}); Cs: Per cent contribution of nutrients from soil; Cf: Per cent contribution of nutrients from fertilizer; SN: Soil test value for available N (kg ha^{-1}); SP: Soil test value for available P (kg ha^{-1}); SK: Soil test value for available K (kg ha^{-1}); Cfym: Per cent contribution of nutrients from FYM; ON: Quantity of N applied through FYM (kg ha^{-1}); OP: Quantity of P applied through FYM (kg ha^{-1}); OK: Quantity of K applied through FYM (kg ha^{-1}).

The above equations serve as a basis for prescribing fertilizer doses for specific yield targets ofBlackgram under IPNS for varied soil available nutrient levels.

3. RESULTS AND DISCUSSION

3.1 Grain Yield

The grain yields recorded as a result of various treatments ranged from762 to 1348kg ha^{-1} (Table 1). The highest grain yield of 1347 kg ha^{-1} was recorded in T_9(STCR-IPNS – 1.4 t ha^{-1}) which was significant over all the treatment and the on par with the grain yield 1290 kg ha^{-1} recorded in T_6 - STCR-NPK alone – 1.4 t ha^{-1}. Following treatments T_9 and T_6, T_8- STCR-IPNS -1.2 t ha^{-1}recorded grain yield of 1252 kg ha^{-1}, comparable to the grain yield of T_5- STCR-NPK alone – 1.2 t ha^{-1}(1182 kg ha^{-1}) and T_{11} - Blanket + FYM 12.5 t ha^{-1}(1162 kg ha^{-1}).These treatments were superior to T_7- STCR-IPNS - 1.0 t ha^{-1}.T_4- STCR-NPK alone - 1.0 t ha^{-1} and T_{10} - Blanket (100 % RDF) which recorded grain yields of 1094, 1042 and 1020 kgha^{-1} respectively. All the fertilized treatments were superior to T_2 - FYM alone @ 6.25 t $ha^{-1}$and T_3 - FYM alone @ 12.5 t ha^{-1}which recorded grain yields of 834 and 894 kg ha^{-1} respectively. With a yield of 762 kg ha^{-1}, absolute control (T_1) had the lowest yield. The high targeted yield (1.4 t ha^{-1}) treatments of STCR - NPK and STCR - NPK + FYM @ 12.5 t ha^{-1} exhibited 9.9 and 13.7 percent increase in yield respectively over T_{11} - Blanket recommendation + FYM @ 12.5 t ha^{-1}. Application of NPK fertilizers combined with FYM might have created a favorable soil condition for root development, enhancedcrop growth,yield and nutrient uptake. Among the same yield targets,yield of maize under STCR-IPNS treatments was numerically higher than those under STCR-NPK alone [16].The yield was analogous to integrated nutrient management and formulation of targeted yield equations for blackgram on inceptisols of Odisha [17]. "Such increase in yields may be due to the improvement in physical and chemical environment of soil as residual effect of addition of farmyard manure. Integration of inorganic fertilizers and biofertilizers resulted in better growth, yield and nutrient uptakes in blackgram" [18].

3.2 Nutrient Uptake

The nutrient uptake ranged from 35.24 – 58.64 kg ha^{-1} for N, 17.75 – 22.76 kg ha^{-1} for P and 30.52 – 52.38 kg ha^{-1} for K respectively(Table 1). The maximum uptake of nutrients was observed in T_9 (STCR-IPNS – 1.4 t ha^{-1}) which was comparable with T_6 (STCR-NPK alone – 1.4 t ha^{-1}) with N uptake of 58.64and 57.45 kg ha^{-1}, P uptake of 22.76 and 22.19 kg ha^{-1} and K uptake 52.38 and 51.42 kg ha^{-1} respectively. Next to T_9 and T_6, - T_8(STCR-IPNS – 1.2 t ha^{-1}), T_5 (STCR-NPK alone – 1.2 t ha^{-1}) and T_{11} (Blanket + FYM 12.5 t ha^{-1}) recorded N uptake of 54.42, 53.72 and 53.42 kg ha^{-1}, P uptake of 21.98, 21.52 and 21.37 kg $ha^{-1}$and K uptake of 49.78, 48.81 and 48.27kg ha^{-1} respectively and were comparable among them. These treatments recorded significantly higher uptake than T_7- (STCR-IPNS – 1.0 t ha^{-1}), T_4- (STCR-NPK alone – 1.0 t ha^{-1})and T_{10} - Blanket (100 % RDF) which recorded an uptake of 52.26, 49.82 and 49.21 kg N ha^{-1}, 21.98, 20.34 and 20.12 kg P $ha^{-1}$and 47.60, 45.56 and 44.92 kg K ha^{-1} respectively. FYM alone - 6.25 t $ha^{-1}$and T_3 - FYM alone - 12.5 t ha^{-1}recorded 46.24 and 48.86 kg N uptake ha^{-1}, 18.81 and 19.98 kg P uptake $ha^{-1}$and 36.45 and 40.24 kg K uptake ha^{-1} respectively. Absolute control recorded the lowest NPK uptake of 35.24, 16.84 and 30.52 kg per ha^{-1} respectively.IPNS may have accelerated carbohydrate synthesis and increased glucose translocation from sink to source, resulting in higher production.This could be because FYM has better physical, chemical, and biological properties than NPK alone treatments [19].The energizing impact of STCR-IPNS treatments on uptake was also experienced by other researchers [20][21]. “The uptake pattern observed among the treatments was similar to those observed in barnyard millet by Selvam and co-workers” [22].Blackgram being a leguminous crop may also fix substantial amount of atmospheric N in soil and make it available to the plants. FYM improves the soil physical environment which may become favourable for microbial growth and hence more nutrients become available in soil solution and consequently enhanced uptake by blackgram.

3.3 Response

“The response of fertilizers to grain yield was estimated by finding the difference in grain yield in absolute control and grain yield in different treatments which varied from 72 to 585 kg ha^{-1} (Table 1). The response was higher in T_9: STCR-NPK + FYM @ 12.5 t ha^{-1}– 1.4 t $ha^{-1}$with 585 t ha^{-1} succeeded by T_6: STCR-NPK alone – 1.4 t $ha^{-1}$with 528kg ha^{-1}.The least response was observed in T_2: FYM alone @6.24 t ha^{-1} (72 kg ha^{-1}).The results were similar to the response trend reported by other researchers”[231] on *Typic Rhodustalf* at Coimbatore, Tamil Nadu for hybrid maize. The results revealed that regardless of whether STCR-NPK alone or STCR-IPNS were used, there was a progressive rise in response from lower to higher targets, with the magnitude of the reaction being higher with STCR-IPNS than with STCR-NPK alone. This formed the basis to compute the basic parameters and develop the fertilizer prescription equations under IPNS. Similar results were reported a for pearl millet variety [24].

3.4 Basic Parameters

Pre-sowing soil available NPK, applied fertilizer dosages, grain yield, and NPK uptake acquired from the experiment are all implemented to compute the basic parameters *viz*., nutrient requirement (NR), contribution from soil (Cs), fertilizers (Cf) and FYM (Cfym) (Table 2). The results manifest, blackgram requires 4.77, 4.50 and 5.05 kg N, P_2O_5 and K_2O respectively to generate one quintal of grain yield (Fig.1.).Similar results were reported by other researchers [25] in chickpea on Inceptisol. The per cent contribution of soil and fertilizers were(Table 2) were 15.61 and 48.61 for N, 29.91 and 44.78 for $P_2O_5$and 8.12 and 55.72 for K_2O. The per cent contribution of N, P and K from FYM was 37.19, 14.63 and 31.71 respectively (Fig.2.). The contribution of nutrients from FYM is limited, which could be attributed to the fact that FYM has a lower mineralization rate [26]. However, in the case of P_2O_5, the contribution was more from soil than from fertilizer. This trend was smiliar to the results of STCR-IPNS based fertilizer prescriptions for blackgram on Inceptisols of odisha [17].

3.5 Fertilizer Prescription Equations for Blackgram under *Typic rhodustalf*

Under STCR - NPK alone and STCR - IPNS for blackgram, the basic parameters NR, Cs, Cf, and Cfym were employed to build fertilizer prescription equations.

STCR-NPK	STCR-NPK +FYM
FN = 9.81 T - 0.32 SN	FN = 9.81 T - 0.32 SN - 0.77ON
FP_2O_5 = 10.05 T - 1.53 SP	FP_2O_5 = 10.05 T - 1.53 SP - 0.75OP
FK_2O = 9.06 T - 0.18 SK	FK_2O = 9.06 T - 0.18 SK - 0.69OK

3.6 Fertilizer Prescription for Blackgram

For blackgram on *Alfisol,* the FPEs were used to develop ready reckoners for a range of soil test values at desired production targets of 1.0, 1.2 and 1.4 t ha^{-1}. (Table3,4,5).It is observed that with soil test values of 220:60:330 kg ha^{-1} of $KMnO_4$-N, Olsen-P, NH_4OAc-K to achieve a grain yield of 1.0,1.2 and 1.4 t $ha^{-1}$the calculated fertilizer doses of N, P_2O_5 and K_2O for NPK alone was 28:25:31 and 37.5:29:37.5 and 37.5:49:37.5 respectively. Under STCR-IPNS, when FYM @ 12.5 t $ha^{-1}$was applied (24% moisture 0.54% N, 0.26% P and 0.51% K) the 39,19 and 34kg of

Table 1. Mean and range of grain yield, pre-sowing soil test values, NPK uptake, and response of Blackgram

Treatment	GrainYield	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	762	35.24	17.75	30.52	224	58	328	0	0	0	0	
T_2	834	46.24	18.81	36.45	221	61	331	0	0	0	6.25	72
T_3	894	48.86	19.98	40.24	226	59	332	0	0	0	12.5	132
T_4	1042	49.82	20.34	45.56	230	57	330	23	10	39	0	280
T_5	1182	53.72	21.52	48.81	222	60	328	44	25	49	0	420
T_6	1290	57.45	22.19	51.42	224	58	329	66	39	60	0	528
T_7	1094	52.26	21.26	47.60	228	61	332	23	10	39	12.5	332
T_8	1252	54.42	21.98	49.78	227	62	326	44	25	49	12.5	489
T_9	1348	58.64	22.76	52.38	223	59	327	66	39	60	12.5	585
T_{10}	1020	49.22	20.12	44.92	225	57	331	25	50	25	0	258
T_{11}	1162	53.42	21.37	48.27	226	62	332	25	50	25	12.5	400
Range	762-1348	35.24-58.64	17.75-22.76	30.52-52.38	221-230	57-62	326-332					
Mean	1080	50.84	20.73	45.09	225	59	330					
SEd	18.43	0.92	0.28	0.54								
CD(P=0.05)	39	1.93	0.59	1.16								

Where UN: Uptake of nitrogen(kg ha^{-1}), UP: Uptake of phosphorus(kg ha^{-1}), and UK: Uptake of potassium(kg ha^{-1})

Table 2. Basic parameters

	N	P_2O_5	K_2O
NR (kg q^{-1})	4.77	4.50	5.05
Cs(%)	15.61	29.91	8.12
Cf(%)	48.61	44.78	55.72
Cfym (%)	37.19	14.63	31.71

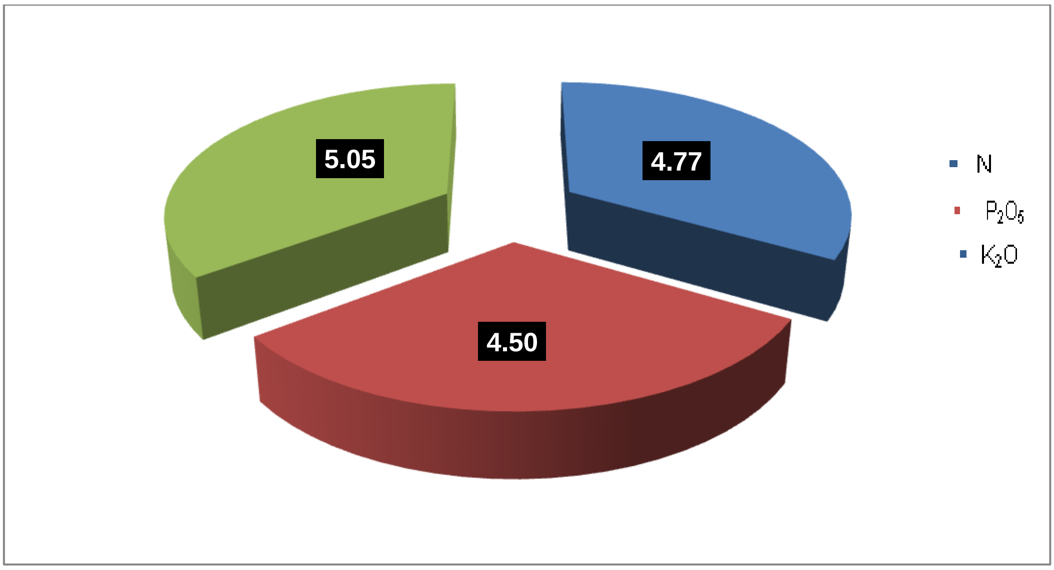

Fig.1. Nutrient Requirement (NR-kg q^{-1})

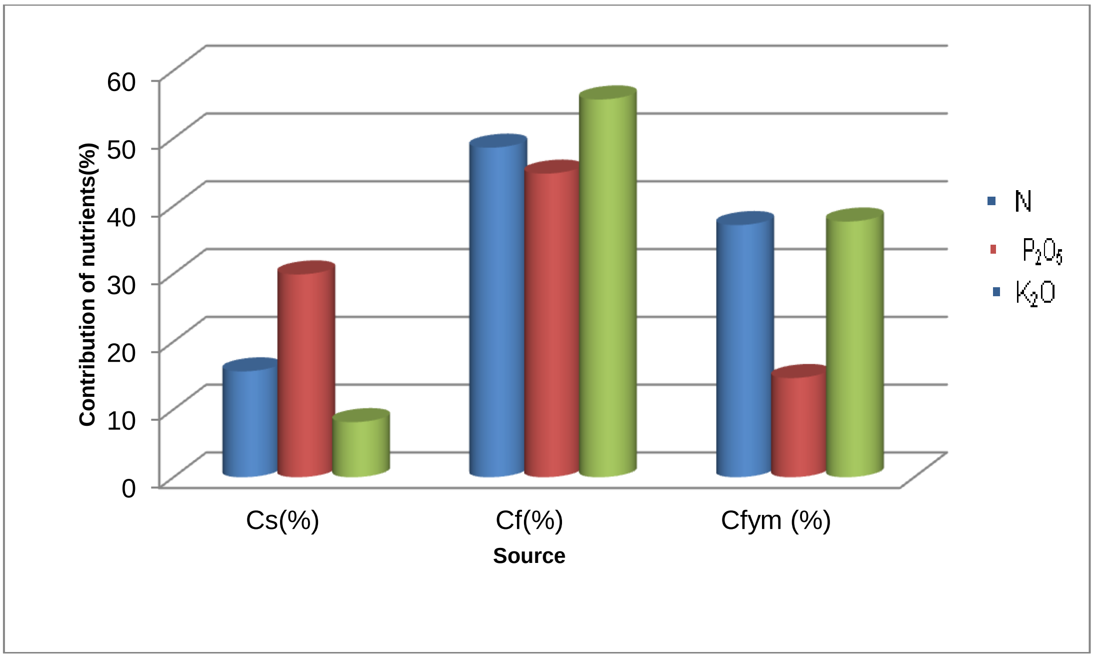

Fig.2.Contribution of nutrients from soil (Cs), fertilizer (Cf),and (Cfym)

Table 3. Ready reckoner of fertilizer doses for STCR-NPK alone, STCR-IPNS (FYM) for desired yield target of 1.0 t ha^{-1} of Blackgram

Soil Test Value (kg ha^{-1})	Treatments		
	STCR –NPK Alone	**STCR –IPNS**	**Percent reduction of fertilizer due to IPNS over STCR-NPK alone**
$KMnO_4$ - N			
180	37.5**	12.5*	66.7
200	34	12.5*	63.2
220	28	12.5*	55.4
240	21	12.5*	40.5
260	15	12.5*	16.7
280	12.5*	12.5*	66.7
Olsen – P			
45	32	25*	22.0
50	25*	25*	0
55	25*	25*	0
60	25*	25*	0
65	25*	25*	0
70	25*	25*	0
NH_4OAc – K			
300	37	12.5*	66.2
320	33	12.5*	62.1
340	29	12.5*	56.9
360	26	12.5*	51.9
380	22	12.5*	43.2
400	19	12.5*	34.2

*(NB: **maximum dose; *maintenance dose)*

Table 4. Ready reckoner of fertilizer doses for STCR-NPK alone, STCR-IPNS (FYM) for desired yield target of 1.2 t ha^{-1} of Blackgram

Soil Test Value (kg ha^{-1})	Treatments		
	STCR –NPK Alone	**STCR –IPNS**	**Percent reduction of fertilizer due to IPNS over STCR-NPK alone**
$KMnO_4$ - N			
180	37.5**	21	44.0
200	37.5**	14	62.7
220	37.5**	12.5*	66.7
240	37.5**	12.5*	66.7
260	35	12.5*	64.3
280	28	12.5*	55.4
Olsen – P			
45	52	33	36.5
50	44	25	43.2
55	36	25*	30.6
60	29	25*	13.8
65	25*	25*	0
70	25*	25*	0
NH_4OAc – K			
300	37.5**	21	44.0
320	37.5**	17	54.7
340	37.5**	14	62.7
360	37.5**	12.5*	66.7
380	37.5**	12.5*	66.7
400	37	12.5*	66.2

*(NB: **maximum dose; *maintenance dose)*

Table 5. Ready reckoner of fertilizer doses for STCR-NPK alone, STCR-IPNS (FYM) for desired yield target of 1.4 t ha^{-1} of Blackgram

Soil Test Value (kg ha^{-1})	Treatments		
	STCR –NPK Alone	**STCR –IPNS**	**Percent reduction of fertilizer due to IPNS over STCR-NPK alone**
$KMnO_4$ - N			
180	37.5**	37.5**	0
200	37.5**	34	9.3
220	37.5**	28	25.3
240	37.5**	21	44.0
260	37.5**	15	60.0
280	37.5**	12.5*	66.7
Olsen – P			
45	72	53	26.4
50	64	45	29.7
55	57	38	33.3
60	49	30	38.8
65	41	25*	39.0
70	34	25*	26.5
NH_4OAc – K			
300	37.5**	37.5**	0
320	37.5**	35	6.7
340	37.5**	32	14.7
360	37.5**	28	25.3
380	37.5**	25	33.3
400	37.5**	21	44.0

*(NB: **maximum dose; *maintenance dose)*

fertilizer N, P2O5 and K2O respectively, could be reduced. The percent reduction due to IPNS over NPK alone was 66.7,13.8,58.6 and 25.3,38.8,10.3 percent for the yield target of 1.2 and 1.4 t ha -1 respectively. The percent reduction of NPK fertilizers under NPK+FYM increased as soil available N, P, and K increased, whereas it decreased as yield targets increased, which is consistent with Sivaranjani and co- workers on *Vertic Ustropept* in Coimbatore[16], and Udayakumar and Santhi on *Typic Ustropept* in Coimbatore, Tamil Nadu for pearl millet [27].

- Blanket dose: 25:50:25 kg ha^{-1} of fertilizer N, $P_2O_5$and K_2O respectively for blackgram.
- If the calculated fertilizer dose tends to fall below 50 per cent of the blanket, a maintenance dose of 50 per cent of the blanket is recommended.
- If the calculated dose exceeds 150 per cent of the blanket, a maximum dose of 150 per cent of the blanket is recommended for N, $P_2O_5$and K_2O respectively.

4. CONCLUSION

The results of this experiment revealed that the fertilizer prescription equations for blackgram on *Typic Rhodustalf* (red, non-calcareous, Palaviduthi soil series) have been developed.According to the findings, combining organic manures and inorganic fertilizers resulted in higher nutrient uptake than using either organic or inorganic fertilizers alone or using no fertilizers at all. This could be because the balanced and combined use of various plant nutrient sources results in proper absorption, translocation, and assimilation of those nutrients, resulting in increased dry-matter accumulation and nutrient contents of the plant, and thus more uptake of nutrients, which has a direct impact on increased agricultural production.In addition to ensuring sustainable crop production, the precise yield equations based on soil test will direct farmers towards the economic use of fertilizer inputs depending on their financial situation and the current market price of the crop under consideration resulting in enhanced fertilizer use efficiency and farm income.Hence, this study provides a dual benefit to farmers where they can aim for desired yield targets based on their resource availability which would result in sustained soil fertility.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/88669