D-5891
[1-7]

RESEARCH ARTICLE Agricultural Science Digest

Enhancing Blackgram Yield: Validating a Soil Test-driven Fertilizer Prescription Equation for *Alfisol*

C. Krithika[1], R. Santhi[1], S. Maragatham[1], D. Vijayalakshmi[2], R. Parimala Devi[3]

10.18805/ag.D-5891

ABSTRACT

Background: On-farm testing of fertilizer prescription equations is imperative to demonstrate the efficacy of technology implementation for the benefit of the stakeholders. The current research was conducted on a farmer's holding, using blackgram (*Vigna mungo* L. Hepper), to evaluate the fertiliser prescription equations (FPEs) in the Thondamuthur block of Coimbatore district, Western Zone of Tamil Nadu. The treatments included control, blanket, blanket + FYM, Soil Test Crop Response (STCR) based fertilizer dose for an yield target of 1.0, 1.2 and 1.4 t ha^{-1}, STCR-IPNS based fertilizer dose for an yield target of 1.0, 1.2 and 1.4 t ha^{-1} and farmer's practice.

Methods: Using the data of yield and fertilizer doses applied, parameters *viz*., per cent achievement, response ratio (RR), benefit: Cost ratio (BCR) were computed.

Result: STCR-IPNS with a targeted yield of 1.4 t ha^{-1} consistently displayed the most substantial growth, superior yield and yield-related characteristics, with the per cent achievement falling within ±10 per cent variation. Furthermore, it exhibited a higher response ratio (RR) and a more favourable Benefit Cost Ratio (BCR) when compared to both farmer's practice and blanket fertilizer recommendations. The results revealed that the target yield has been achieved within ±10 per cent variation proving the validity of the equations.

Key words: Benefit: Cost ratio, Growth, Per cent achievement, Response ratio, Yield.

INTRODUCTION

Blackgram [*Vigna mungo* (L.) Hepper] ranks as the third most significant pulse crop in India, thriving across diverse agro-climatic regions throughout the country. It is suitable for cultivation in both atypical and typical weather conditions. It is highly regarded as the most economical source of plant protein in the diet of economically poor. It holds substantial importance in terms of food, energy and nutritional security, boasting approximately 24 per cent protein content, 60 per cent carbohydrates, as well as fats, minerals and essential amino acids like methionine and cysteine. In addition to being an important source of human food and animal feed, plays an important role in sustaining soil fertility. By improving soil physical properties and fixing atmospheric nitrogen, it is a drought resistant crop suitable for dryland farming and predominantly used as an intercrop with other crops.

Achieving maximum crop yields from high-yielding varieties necessitates the precise application of optimal nutrient doses (Sharma *et al*., 2015). However, the rising costs and limited availability of fertilizers have led to insufficient and imbalanced fertilization practices. Additionally, the lack of knowledge about soil characteristics and crop nutrient requirements hinders the realization of crop yield potential and can degrade soil health, resulting in economic losses for farmers (Sharma *et al*., 2016; Singh *et al*., 2015).

Determining the right fertilizer dosage for a crop should be based on several factors, including the crop's response to added nutrients, the specific nutrient needs of the crop, the availability of nutrients from native sources in the soil and the long-term impact of added fertilizers (Dobermann *et al*., 2003). Therefore, a comprehensive approach that takes into account soil testing results, crop requirements and economic viability should be employed when deciding on fertilizer usage. In this regard, the Soil Test Crop Response (STCR) approach can be adopted to calculate the fertilizer requirements for different crops. The nitrogen, phosphorus and potassium (NPK) requirements exhibit a linear correlation with the target yield (TY), which is contingent upon the soil test values (STVs). Therefore, this current study aimed to (i) verify the validity of these equations in attaining target yields and (iii) evaluate the effectiveness of STCR treatments in conjunction with different existing nutrient management approaches, focusing on grain yield, response ratio, percentage of target achievement and economic considerations.

[1]Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[2]Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-641 003 Tamil Nadu, India.
[3]Department of Renewable Energy Engineering, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.

Corresponding Author: C. Krithika, Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
Email: krithikac1706@gmail.com

How to cite this article: Krithika, C., Santhi, R., Maragatham, S., Vijayalakshmi, D. and Devi, R.P. (2023). Enhancing Blackgram Yield: Validating a Soil Test-driven Fertilizer Prescription Equation for *Alfisol*. Agricultural Science Digest. DOI: 10.18805/ag.D-5891

Submitted: 04-10-2023 **Accepted:** 06-12-2023 **Online:** 18-12-2023

MATERIALS AND METHODS

Experimental site

The validation field experiment was conducted with Blackgram (variety: VBN 11) during *Rabi* season of 2022-2023 within a farmer's field, situated in the Thondamuthur block of Coimbatore district to validate the soil test crop response (STCR) targeted yield equations developed in main experiment in terms of grain yield, per cent deviation from the fixed target and economics in comparison with other approaches of fertilizer recommendations. Fertiliser Prescription Equations (FPEs) on Palaviduthi soil series (*Typic Rhodustalf*) and the FPEs are provided below:

$$FN = 9.81\ T - 0.32\ SN - 0.77\ ON$$

$$FP_2O_5 = 10.05\ T - 1.53\ SP - 0.75\ OP$$

$$FK_2O = 9.06\ T - 0.18\ SK - 0.69\ OK$$

The experiment was laid out in randomized block design (RBD) with ten treatments and three replications. Treatments comprised of T_1 - STCR - NPK alone - 1.0 t ha^{-1}, T_2 - STCR - NPK alone - 1.2 t ha^{-1}, T_3 - STCR - NPK alone - 1.4 t ha^{-1}, T_4 - STCR - IPNS - 1.0 t ha^{-1}, T_5 - STCR - IPNS - 1.2 t ha^{-1}, T_6 - STCR - IPNS - 1.4 t ha^{-1}, T_7 - Blanket (100% RDF alone), T_8 - Blanket (25:50:25) + FYM @ 12.5 t ha^{-1}, T_9 - Farmer's practice, T_{10} - Absolute control. A composite soil sample was collected at 0-15 cm depth and analysed for Soil available N, P and K. The land was initially ploughed and given pre-sowing irrigation to facilitate optimal crop germination and establishment. A basal dose of fertilisers were applied per hectare and FYM were applied in the field as per the treatment details before sowing and mixed in soil. The soil of the experimental site belongs to order *Alfisol*, characterized by sandy loam texture. Specifically, it belongs to the sub-group *Typic Rhodustalf* and is classified as a non-calcareous red soil. The soil characteristics of field was low in soil organic carbon (0.39%), low in soil available nitrogen (255 kg ha^{-1}), high in soil available P (42 kg ha^{-1}) and soil available K (380 kg ha^{-1}) and sufficient in the following soil available micronutrients *viz*., Zn, Cu, Fe and Mn. All intercultural operations were done as per the requirement. The crop was harvested at maturity in the first fortnight of January, 2023. Pre-harvest observations which include plant height (cm), number of nodules plant^{-1}, SPAD reading and Leaf Area Index were observed at 45 DAS (Days After Sowing) and Post-harvest observations like number of pods plant^{-1}, number of clusters plant^{-1}, pod length, 100 seed weight, grain yield, per achievement, Response ratio and benefit:cost ratio were recorded.

Analysis of variance (ANOVA) was performed using R Studio version 4.2.2. Software. The randomized block design (RBD) was used for the experiment and the differences were compared by least significant difference (LSD) test at a significance level of $p<0.05$.

RESULTS AND DISCUSSION

Plant height

The average plant height displayed a range, from 24.65 cm in the absolute control to 35.77 cm in the STCR-IPNS-1.4 t ha^{-1} (Table 1). Notably, the plants in the STCR-IPNS treatments were consistently taller than those in the STCR-NPK alone treatments for the same yield targets. The lowest plant height was recorded with absolute control (24.65 cm). Organic manure release nutrients gradually as they decompose. The breakdown of organic matter is a biological process driven by microbial activity. This gradual release contrasts with mineral fertilizers, which can provide nutrients in a more soluble and quickly available form. This, in turn, might have stimulated early root development and cellular proliferation, leading to increased absorption of nutrients from deeper soil layers. Consequently, these processes contributed to an enhancement in plant height and an overall acceleration in plant growth rates (Kumar *et al*., 2020 and Mohamed *et al*., 2023a).

The combined application of inorganic fertilizers and organic manures had a pronounced positive impact on both plant height and yield, as visually illustrated in Fig 1. This increase in plant height plays a pivotal role in enhancing crop yield. Taller blackgram plants have a greater capacity to harness sunlight, a critical factor for photosynthesis. This heightened photosynthetic activity leads to more efficient energy conversion, ultimately resulting in higher yield. Moreover, taller canopies are particularly advantageous in

Table 1: Effect of Different fertilizer N, P_2O_5, K_2O dosages and IPNS on growth parameters of blackgram.

Tr. no.	Treatments	Plant height (cm)	Leaf area index	Root nodules	SPAD reading
T_1	STCR - NPK alone 1.0 t ha^{-1}	27.16	0.54	37.26	37.49
T_2	STCR - NPK alone 1.2 t ha^{-1}	30.42	0.79	43.88	41.86
T_3	STCR - NPK alone 1.4 t ha^{-1}	32.83	0.97	47.15	45.58
T_4	STCR - IPNS (I) 1.0 t ha^{-1}	29.44	0.68	40.67	39.74
T_5	STCR - IPNS (I) 1.2 t ha^{-1}	31.58	0.86	45.59	43.25
T_6	STCR - IPNS (I) 1.4 t ha^{-1}	35.77	1.25	50.83	47.62
T_7	Blanket (100 % RDF alone	25.26	0.38	30.72	33.17
T_8	Blanket (25:50:25) + FYM @ 12.5 t ha^{-1}	26.54	0.46	33.45	35.53
T_9	Farmer's practice	24.65	0.34	28.21	31.98
T_{10}	Absolute control	23.11	0.32	27.08	29.36
	SEd	0.64	0.02	0.80	0.78
	CD (P=0.05)	1.36	0.04	1.68	1.64

competitive cropping environments as they can capture light more effectively, further contributing to yield improvement (Sharma and Abraham, 2010; Malarvizhi and Sabarinath, 2021; Tiwari *et al*., 2022).

Leaf area index

The leaf area index (LAI) of the plants exhibited a range, starting at 0.32 in the absolute control and reaching 1.25 in the STCR-IPNS-1.4 t ha^{-1} (Table 1). Notably, the STCR-IPNS-1.4 t ha^{-1} treatment stood out with a significantly higher LAI of 1.25 compared to all other treatments. In contrast, the farmer's practice (0.34) and the absolute control (0.32) recorded significantly lower LAI values than the remaining treatments. The application of nitrogen significantly augmented leaf area, likely attributable to its role in enhancing nutrient assimilation by the plant, thereby promoting heightened meristematic cell activities. This cascade effect ultimately resulted in an increased leaf count, along with expanded leaf dimensions in terms of length and width. Furthermore, the provision of major nutrients through chemical fertilizers positively influenced photosynthetic activity, nutrient metabolism and auxin content within the plants. As a consequence, these factors collectively contributed to the enhancement of plant stature, leaf count and leaf area index. Notably, similar findings were reported by (Uma Maheswari and Karthik, 2017; Karthikeyan *et al.,* 2020).

Root nodules

The mean data pertaining to the number of nodules per plant, influenced by various treatments, are presented in Table 1. The treatment STCR-IPNS 1.4 t ha^{-1} exhibited the highest nodule count, with a mean of 50.83, which was significantly greater than all other treatment groups. It is important to note that all the STCR treatments significantly outperformed the farmer's practice, which yielded an average nodule count of 28.21, as well as the absolute control, which showed an average nodule count of 27.08. The augmentation of nodulation and nitrogen-fixation, coupled with sufficient phosphorus assimilation, is likely responsible for the observed increase in nodulation in blackgram (Abraham and Lal, 2004). Elevated nutrient levels appear to be correlated with a heightened nodule population per plant, potentially contributing to enhanced root biomass. The concurrent use of inorganic fertilizers and organic manures had a beneficial impact on both root nodules and grain yield in blackgram, as visually represented in Fig 2. Root nodules in blackgram are a valuable contributor to increased yield because they serve as a direct and sustainable source of nitrogen, boost plant health, facilitate efficient photosynthesis and enhance pod development and seed filling. These combined effects culminate in amplified crop yield and overall agricultural productivity. Notably, the highest counts of root nodules and grain yield were recorded in STCR- IPNS-1.4 t ha^{-1} treatment, while the lowest values were observed in absolute control.

SPAD reading

The mean SPAD readings in blackgram exhibited a range, from 29.36 in the absolute control to 47.62 in the STCR-IPNS-1.4 t ha^{-1} treatment (Table 1). The maximum LAI was documented with STCR-IPNS-1.4 t ha^{-1} (47.62) followed by same target with inorganics alone (45.58) and the lowest LAI was registered with Absolute control (29.36). In case of STCR-IPNS, a higher chlorophyll content was observed compared to the blanket application and this enhancement can be attributed to the unique nutrient blend employed within this specific treatment, as elucidated by Vishnu *et al.* (2022). This emphasizes the intricate relationship between phosphorus (P) and crucial energy molecules like ATP and ADP, which play pivotal roles in facilitating energy transfer during various metabolic reactions within living cells, including significant biological energy transformations. Consequently, variations in phosphorus levels have a profound influence on chlorophyll content, underscoring the integral connection between nutrient availability and photosynthetic pigment production. SPAD values (chlorophyll) of blackgram and grain yield were positively influenced by combined application of organics and inorganics leading to better vegetative growth was, therefore, observed (Fig 3). The more chlorophyll a plant has, the more efficiently it can photosynthesize. Enhanced photosynthesis is directly linked to increased yield because it provides the

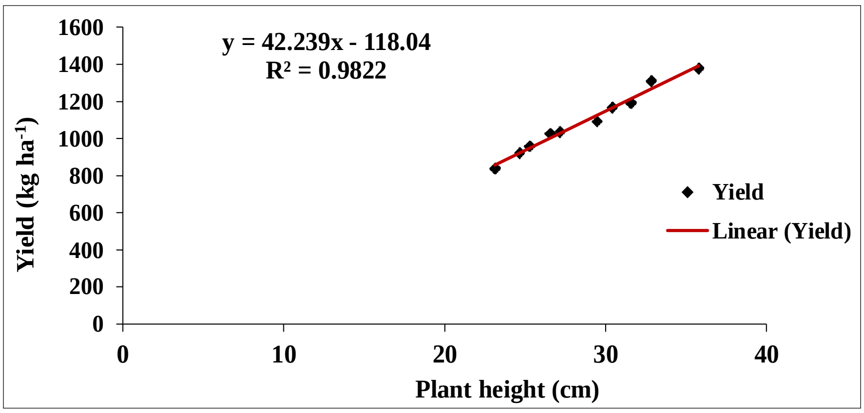

Fig 1: Relationship between yield and plant height with different fertiliser N, P_2O_5, K_2O dosages and IPNS.

source-sink relationship for the plant to grow, develop and produce. The highest SPAD values and grain yield were observed in STCR- IPNS-1.4 t ha^{-1} while the lowest one was obtained in the absolute control.

Yield attributes

Fig 4. clearly illustrated that the diverse treatments exerted discernible influences on parameters such as the number of pods $plant^{-1}$, the number of clusters $plant^{-1}$, pod length and the 100 grain weight.

The highest number of pods (64.89) was recorded by the application of STCR-IPNS-1.4 t ha^{-1} which was statistically superior to all other treatments. The next highest number of pods (60.51) was achieved with STCR-NPK alone -1.4 t ha^{-1}. The absolute control recorded the lowest number of pods $plant^{-1}$ (34.46).The number of clusters per plant exhibited variation across treatments, ranging from 9.27 in the absolute control to 18.16 in the STCR-IPNS -1.4 t ha^{-1}. Notably, the STCR-IPNS treatment at 1.4 t ha^{-1} recorded significantly higher number of clusters (18.16), which was comparable to the performance of STCR-NPK-1.4 t ha^{-1}. The lowest number of clusters were recorded with the absolute control (9.27). The length of blackgram pods was meticulously measured under various treatments, revealing statistically significant variations due to these imposed treatments. The data has been visually represented in a Fig 4. Notably, the STCR-IPNS-1.4 t ha^{-1} achieved a significantly higher pod length of 5.81 cm, surpassing all other treatments. On the contrary, the lower pod length recorded with the absolute control (4.08 cm), which were all notably lower than the other treatments. Concurrently, the STCR-IPNS-1.4 t ha^{-1} yielded the highest test weights of 5.05 and the lowest test weight was observed in the absolute control, measuring 4.71. It was noteworthy that the test weight data among the treatments did not exhibit statistically significant differences.

In this context, it is plausible that Rhizobium played a role in promoting rapid root nodulation, leading to increased nitrogen fixation in the plant roots. Additionally, phosphate-solubilizing bacteria may have contributed to the preservation of applied and naturally occurring phosphorus, preventing its conversion into less accessible forms, while simultaneously converting organic phosphorus into forms readily available to the plant. This, in turn, could have resulted in greater phosphorus availability for crucial physiological processes, ultimately leading to the enhancement of yield-related attributes in blackgram. These findings align with previous research conducted by (Jat and Ahlawat 2003; Malik *et al*., 2013 and Sikka *et al*., 2016).

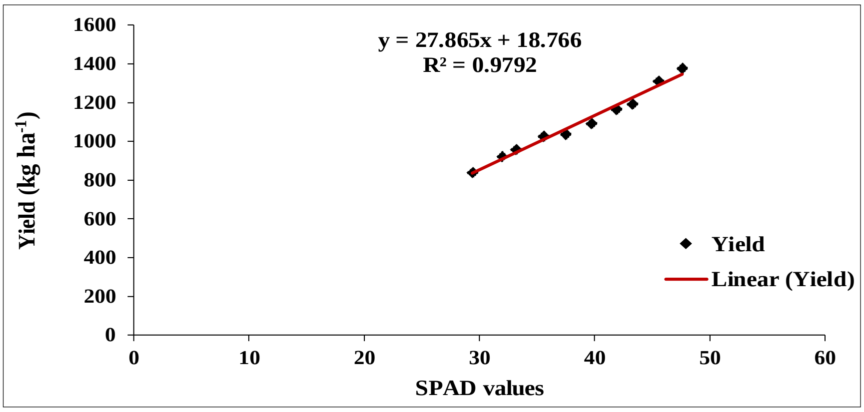

Fig 2: Relationship between yield and SPAD values with different fertiliser N, P_2O_5, K_2O dosages and IPNS.

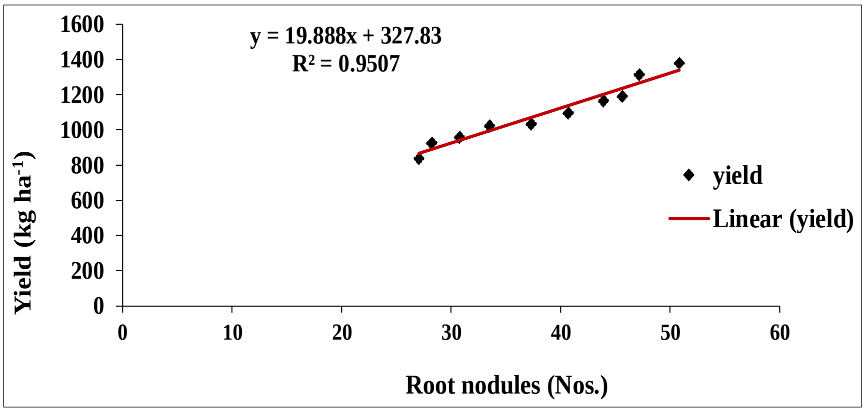

Fig 3: Relationship between yield and root nodules with different fertiliser N, P_2O_5, K_2O dosages and IPNS.

Grain yield

In our study, a notable variation in grain yield was observed across various treatments (Table 2), spanning from 840 kg ha^{-1} as the lowest yield in the absolute control to 1379 kg ha^{-1} as the highest yield achieved by the STCR-IPNS-1.4 t ha^{-1} treatment, as detailed in Table 2 surpassing all other treatments. The absolute control recorded the lowest yield at 840 kg ha^{-1}. In contrast to STCR-NPK alone treatments with corresponding yield objectives, STCR-IPNS treatments consistently exhibited higher yields, emphasizing the advantageous synergy achieved by combining inorganic fertilizers with organic manures. This combination illuminated its superiority in promoting crop productivity. The slower nutrient release from FYM limited its capacity to adequately fulfill the critical nutrient requirements during the key growth stages of the crop. The plausible explanation for this trend could be attributed to the fact that blackgram, being a leguminous crop, has the inherent ability to fix atmospheric nitrogen. The application of farm yard manure (FYM) in this context likely bolstered the nitrogen supply, thereby enhancing grain production and overall crop reproductive efficiency. Although blackgram has the capability to harness atmospheric nitrogen, it initially expends energy to do so. This observation resonates with findings from a study conducted by (Laharia *et al*., 2020; Zannat *et al*., 2020; Mohamed *et al*., 2023b and Anasuyamma *et al*., 2022).

Per cent achievement

The applicability of fertilizer prescription calculations is contingent on the per cent achievement falling within ±10% range of the yield objective. In this context, the per cent attainment ranged from 93.8% in STCR-NPK alone at 1.4 t ha^{-1} to 106.8% in STCR-IPNS at 1.0 t ha^{-1}, demonstrating the suitability of the fertilizer prescription equations for blackgram across all three yield target levels, both within the STCR-NPK alone and IPNS categories (Table 2). Within the STCR-IPNS category, the highest yield target achievement was observed in STCR-IPNS-1.0 t ha^{-1} (106.8 %), followed by STCR-IPNS 1.2 t ha^{-1} (99.3%) and STCR-IPNS 1.0 t ha^{-1} (98.5%). In contrast, for STCR-NPK alone, the per cent accomplishment for yield targets of 1.0, 1.2 and 1.4 t ha^{-1} stood at 103.6%, 97.3% and 93.8%, respectively. These results indicate that yield targeting with IPNS consistently achieved a higher percentage of the desired target compared to yield targeting with NPK alone treatments. Similar results were reported by Dey and Bhogal (2016); Santhi *et al.* (2017) and Udayakumar and Santhi (2016) for pearl millet; Selvam *et al.* (2022) on barnyard millet, (Abishek *et al*., 2022) on castor and Mohamed (2023) for finger millet.

Response ratio and BCR

The response ratio recorded for various treatments ranged from 1.05 kg kg^{-1} in farmer's practice to 3.40 kg kg^{-1} in STCR-IPNS-1.0 t ha^{-1} followed by in STCR-IPNS- 1.2 t ha^{-1} (2.67), STCR-NPK alone -1.4 t ha^{-1} (2.61 kg kg^{-1}) and STCR- IPNS-1.4 t ha^{-1} (2.57 kg kg^{-1}) represented in Table 2. Among the

Table 2: Effect of Different fertilizer N, P_2O_5, K_2O dosages and IPNS on yield of blackgram.

Tr. no.	Treatments	FYM (t ha^{-1})	Fertiliser doses (kg ha^{-1}) FN	FP_2O_5	FK_2O	Grain yield (kg ha^{-1})	Per cent achievement	RR (kg kg^{-1})	B.C ratio
T_1	STCR - NPK alone 1.0 t ha^{-1}	-	17	36	22	1036	103.6	2.61	2.25
T_2	STCR - NPK alone 1.2 t ha^{-1}	-	36	56	38**	1168	97.3	2.48	2.35
T_3	STCR - NPK alone 1.4 t ha^{-1}	-	38**	75**	38**	1313	93.8	2.25	2.47
T_4	STCR - IPNS - 1.0 t ha^{-1}	12.5	13*	17	13*	1095	106.8	3.40	2.52
T_5	STCR - IPNS - 1.2 t ha^{-1}	12.5	13*	37	13*	1192	99.3	2.67	2.63
T_6	STCR - IPNS - 1.4 t ha^{-1}	12.5	17	57	24	1379	98.5	2.57	2.87
T_7	Blanket (100 % RDF alone)	-	25	50	25	958	-	1.18	2.11
T_8	Blanket (25:50:25) + FYM @ 12.5 t ha^{-1}	12.5	25	50	25	1027	-	1.87	2.15
T_9	Farmer's practice	-	20	40	20	924	-	1.05	2.06
T_{10}	Absolute control	-	0	0	0	840	-	-	2.01
					SE (d)	22			
					CD (0.05)	46			

*Maintenance dose ** maximum dose.

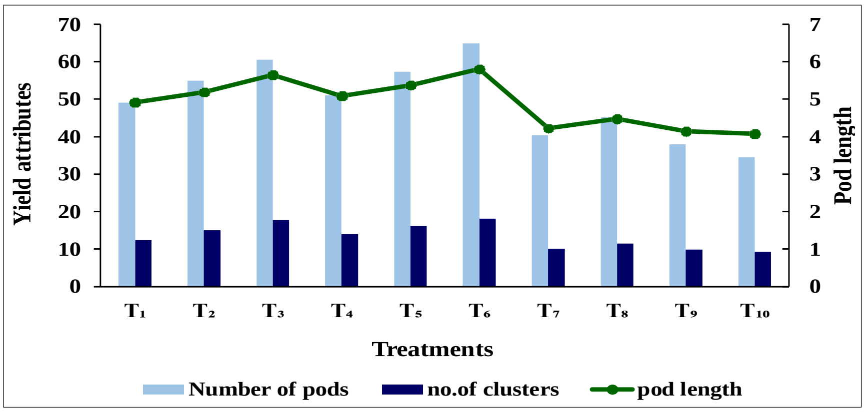

Fig 4: Effect of different fertilizer N, P_2O_5 and K_2O dosages and IPNS on yield attributes of blackgram.

STCR treatments, STCR-IPNS recorded relatively higher RR than their corresponding STCR-NPK alone treatments. Blanket (100% RDF alone) and blanket plus FYM @ 12.5 t ha^{-1} recorded 1.87 and 1.18 kg kg^{-1}, respectively, which was relatively lower as compared to all STCR treatments. The BCR data revealed that STCR-IPNS-1.4 t ha^{-1} (2.99) had the greatest value, followed by STCR-NPK alone - 1.2 t ha^{-1} (2.77). Among STCR treatments, the BCR of STCR-IPNS was considerably greater than that of STCR-NPK alone. The blanket (100 % RDF alone) and farmer's practice BCRs were 2.09 and 2.06, respectively, lower than all STCR treatments. The variations in benefit-cost ratios (BCRs) were primarily linked to differences in crop yields and varying costs arising from the incorporation of organic manures. It becomes apparent that the judicious application of organic manures, such as on-farm farm yard manure (FYM), in conjunction with inorganic fertilizers, yields a more lucrative income. These findings align with previous research conducted by Lakum *et al.* (2011), Choudhary *et al*. (2014), Sipai *et al*. (2014), Singh and Chauhan (2016) and Meena *et al.* (2017), all of whom reported similar positive outcomes regarding the combined use of organic and inorganic inputs for enhanced profitability.

CONCLUSION

In summary, the achievement of the targeted yield for blackgram trials fell within a ±10% variation range, affirming the validity of the equations used to recommend integrated fertilizer doses. Among the various treatments, it was observed that STCR-IPNS-1.4 t ha^{-1} resulted in significantly higher grain yields compared to all other approaches, while blanket fertilizer recommendations led to significantly lower yields. STCR-IPNS-1.4 t ha^{-1} outperformed both the traditional farmers' practices and blanket recommendations by exhibiting enhanced growth, yield, yield attributes, a higher response ratio and a more favorable productivity benefit-cost ratio.

The STCR approach serves the vital function of tailoring nutrient application to the specific needs of the crop while accounting for nutrient replenishment from the soil. These targeted yield-based fertilizer prescription models for blackgram are dynamic and can be adjusted based on changes in soil nutrient availability. Therefore, the fertilizer prescription equations developed for blackgram under IPNS are recommended for use in red non-calcareous - Palaviduthi soil series (*Typic Rhodustalf*) in Tamil Nadu, facilitating the achievement of specific yield targets while maintaining soil health in the long term.

Conflict of interest

There are no conflicts of interest.

REFERENCES

Abishek, R., Santhi, R., Maragatham, S., Gopalakrishnan, M., Venkatachalam, S., Uma, D., Lakshmanan, A. (2022). Soil test crop response based integrated plant nutrition system for hybrid castor on an *Alfisol.* Agricultural Science Digest. D: 1-6. DOI: 10.18805/ag.D-5635.

Abraham, T. and Lal, R. (2004). Performance of blackgram (*Vigna mungo* L.) under integrated nutrient management (INM) in a legume based cropping system for the *Inceptisols* of NEPZ. Indian Journal of Dryland Agricultural Research and Development. 19(1): 81-87.

Anasuyamma, B., Singh, S., Asirinaidu, B. and Abhigna, K. (2022). Effect of organic manures and Inorganic fertilisers on the growth and yield of Blackgram (*Vigna mungo* L.). The Pharma Innovation Journal. 11(4): 1214-1218

Choudhary, R., Yadav, L., Shivran, A. and Parihar, S. (2014). Effect of vermicompost and fertility levels on the growth, yield, nutrient uptake and net returns in pearl millet (*Pennisetum glaucum*). Indian Journal of Agricultural Sciences. 84(11): 1428-1430.

Dey, P. and Bhogal, H. (2016). In: Progress Report (2013-16) of the All India Coordinated research Project for Investigation on Soil Test Crop Response Correlation. Indian Institute of Soil Science, Bhopal. 1-224.

Dobermann, A., Witt, C., Abdulrachman, S., Gines, H.C.R., Nagarajan, T., Son, T., Tan, P.S., Wang, G. H., Chien, N.V. and Thoa, V.T.K. (2003). Soil fertility and indigenous nutrient supply in irrigated rice domains of Asia. Agronomy Journal. 95(4): 913-23. doi: 10.2134/agronj2003.9130.

Jat, H.S. and Ahlawat, I.P.S. (2003). Response of pigeonpea (*Cajanus cajan*) + groundnut (*Arachis hypogaea*) intercropping system to planting pattern and phosphorus management. Indian Journal of Agronomy. 48(3): 156-159.

Karthikeyan, P., Kamaleshwaran, R. and Bhuvaneswari, R. (2020). Effect of muraite of potash on growth, yield and available nutrient uptake of blackgram (VBN-3) in the coastal soils of Tamil Nadu, India. Plant Archives. 20(1): 1035-1038.

Kumar, R., Baba, A.Y., Singh A. B. K. and Kumar, M. (2020). Growth, yield and economics performance of black gram [*Vigna mungo* (L.) Hepper] as influenced by organic and inorganic source of nutrients under sodic soil conditions. Plant Archives. 20(2): 7991-7994.

Laharia, G., Kadam, Y., Age, A., Jadhao, S., Mali, D. and Rakhonde, O. (2020). Interactive effect of biochar, fym and nitrogen on soil properties and yield of blackgram grown in *vertisol*. Journal of Pharmacognosy and Phytochemistry. 9(6): 249-253.

Lakum, Y., Patel, S. and Mehta, P. (2011). Reducing fertilizer requirement with the use of bio-fertilizers in summer pearl millet [*Pennisetum glaucum* (L.)]. Asian Journal of Soil Science. 6 (1): 50-53.

Malarvizhi, C. and Sabarinath, B.S. (2021). Comparative study of inorganic fertilizers and organic manures on growth and yield components of blackgram (*Vigna mungo* L.). Plant Archives. 21(1): 2683-2686.

Malik, J.K., Singh, R., Thenua, O.V.S. and Kumar, A. (2013). Response of pigeonpea (*Cajanus cajan*) + mungbean (*Phaseolus radiatus*) intercropping system to phosphorus and biofertilizers. Legume Research. 36(4): 323-330.

Meena, R., Maurya, S. and Meena, R. (2017). Productivity, soil properties and economics of rainfed pearl millet as influenced by mulching and organic sources of nutrients. International Journal of Current Microbiology and Applied Science. 6(2): 566-574.

Mohamed, A.B. (2023). Fertiliser Prescription for Finger Millet through Integrated Plant Nutrition System Based on Inductive cum Targeted Yield Concept on *Alfisol*. Ph.D. (Ag.) Thesis, submitted to TNAU, Coimbatore.

Mohamed, B.A., Santhi, R., Maragatham, S., Gopalakrishnan, M., Ravikesavan, R. and Geetha, P. (2023b). Sustaining soil fertility and yield by inductive cum targeted yield model-based fertilizer prescriptions for finger millet (*Eleusine coracana* L.) in *Alfisols* of Tamil Nadu, Southern India. Agricultural Science Digest. 1(7): 5762. doi: 10.18805/ag.D-5762.

Mohamed, B.A., Santhi, R., Maragatham, S., Ravikesavan, R., Geetha, P., Gopalakrishnan, M. and Parimala Devi, R. (2023a). Impact of soil fertility characteristics on artificial fertility gradient approach developed using sorghum (*Sorghum bicolor*) in *Alfisols*. Journal of Applied and Natural Science. 15(2): 793-801.

Santhi, R., Sellamuthu, K.M., Maragatham, S., Natesan, R., Arulmozhiselvan, K., Kumar, K. and Dey, P. (2017). Soil test and yield target based fertiliser prescriptions for crops-an overview of outreach activities in tribal villages of Tamil Nadu (in Tamil). AICRP-STCR, Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore-641003.

Selvam, R., Santhi, R., Maragatham, S., Chandrasekhar, C.N. and Ganapathi, P.S. (2022). Effect of initial soil fertility and integrated plant nutrition system on yield and npk uptake by barnyard millet. International Journal of Plant and Soil Science. 34(4): 40-47.

Sharma, G.K., Mishra, V.N., Maruti, S.G.R., Patil, S.K., Srivastava, L.K., Thakur, D.S. and Rao, S. (2015). Soil-test-based optimum fertilizer doses for attaining yield targets of rice under midland *Alfisols* of Eastern India. Communications in Soil Science and Plant Analysis. 46(17): 2177-90. doi: 10.1080/00103624.2015.1069319.

Sharma, V.K., Pandey, RN., Sarvendra, K., Chobhe, K.A. and Suresh, C. (2016). Soil test crop response based fertilizer recommendations under integrated nutrient management for higher productivity of pearl millet (*Pennisetum glaucum*) and (*Triticum aestivum*) wheat under long term experiment. Indian Journal of Agricultural Sciences. 86: 1076-81.

Sharma, V. and Abraham, T. (2010). Response of blackgram (*Phaseolus mungo*) to nitrogen, zinc and farmyard manure. Legume Research. 33(4): 295-298.

Sikka, R., Singh, D., Deol, J.S. and Kaur, J. (2016). Productivity enhancement of soybean as influenced by integrated nutrient and other agronomic interventions in sub-humid Punjab, India. Legume Research. 39(5): 768-773. Doi: 10.18805/lr.v0iOF.9433.

Singh, S.R., Maitra, D.N., Kundu, D.K., Majumdar, B., Saha, A.R. and Mahapatra, B.S. (2015). Integrated fertilizer prescription equations for recommendations of fertilizers in jute-rice-garden pea sequence on alluvial soil of Eastern India. Communications in Soil Science and Plant Analysis. 46(1): 1-15. doi: 10.1080/00103624.2014. 882350.

Singh, S. and Chauhan, S. (2016). Effect of integrated nutrient management on pearl millet crop grown in semi-arid climate. Advanced Journal Multidisplinary. Advance Research. 5(2): 54-57.

Sipai, A., Jat, J., Nakrani, B. and Gadhavi, S. (2014). Integrated nutrient management in bajra. An Asian Journal of Soil Science. 9(1): 155-157.

Tiwari, K.S., Mehera, B. and Kumar, N. (2022). Effect of biofertilizers and phosphorus on growth and yield of blackgram (*Vigna mungo* L.). The Pharma Innovation Journal. 11(5): 2269-2272.

Udayakumar, S. and Santhi, R. (2016). Effect of integrated plant nutrition system (IPNS) and initial soil fertility on yield and NPK uptake by pearl millet on *Inceptisol*. International Journal of Agriculture Sciences. 8(55): 3020-3024.

Uma Maheswari, M. and Karthik, A. (2017). Effect of foliar nutrition on growth, yield attributes and seed yield of pulse crops. International Journal of Current Microbiology and Applied Sciences. 6(11): 4134-4139

Vishnu, M., Singh, R.D., Gurusamy, A., Prabakaran, K. and K. Kalpana. (2022). Effect of various irrigation regimes on growth and yield of blackgram (*Vigna mungo*) under Sub-Tropical regions of Southern Tamil Nadu, India. Research on Crops. 23(1): 63-69.

Zannat, N.E.A., Sultana, A.K.M., Amin, R., Ruhul, Bithy, P., Puja, C. and Alam, I. (2020). Influence of organic and inorganic fertilizers on the yield of blackgram. International Journal of Biosciences. 16(3): 79-89.