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Development in Soil Test Crop Response Correlation – A Review

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Abstract

Soil Test Crop Response (STCR)–based fertilizer prescription under Integrated Plant Nutrient System (IPNS) offers a precise approach for achieving targeted crop yields while maintaining soil fertility. Several field studies conducted across diverse soil types and agro-ecological regions demonstrated that STCR-IPNS significantly enhanced crop yield, nutrient uptake, fertilizer use efficiency and economic returns compared to blanket recommendations and farmers' practices. Integration of farmyard manure with chemical fertilizers consistently reduced fertilizer requirement without compromising yield targets. Yield achievements were generally within ±10% of the targeted levels, confirming the validity of fertilizer prescription equations. Post-harvest soil analysis revealed improved or sustained soil fertility under STCR-IPNS. Overall, the STCR-based targeted yield approach provides a reliable framework for sustainable and site-specific nutrient management in modern agriculture.

Key words : Soil test crop response, nutrient requirement, contribution, FYM, VC .

Soil is a fundamental natural resource and the primary source of nutrients for global agriculture. Maintaining soil health and quality is essential for boosting crop yields and sustaining an expanding global population. While fertilizers represent one of the most significant financial investments in farming, applying the correct dosage is vital for both long-term sustainability and environmental safety. Currently, many farmers apply fertilizers without precise data regarding soil fertility or specific crop requirements. This "blind" application often results in nutrient toxicity or deficiency-caused by the over-application of some nutrients and the neglect of others-ultimately harming soil health and hindering productivity.

Research consistently shows that neither organic manure nor chemical fertilizers can achieve agricultural sustainability in isolation. To maintain soil fertility and long-term health, a balanced approach is required. An Integrated Plant Nutrient Management (IPNM) system is necessary, incorporating site-specific data on crop needs, existing soil nutrient levels and the recovery efficiency of applied fertilizers. By utilizing soil testing to guide input decisions, farmers can apply fertilizers more judiciously, ensuring balanced nutrition for crops and a more sustainable environmental footprint.

The Targeted Yield Approach, or Soil Test Crop Response (STCR), is the premier method for balanced fertilization and resource optimization. Originating with Troug (1960) and adapted for India by Ramamoorthy (1967), this approach uses unique prescription equations to calculate nutrient requirements based on specific yield goals. Unlike traditional methods, STCR-further developed by ICAR's AICRP-accounts for the efficiency of both soil and applied nutrients. It provides a scientific framework that not only recommends precise fertilizer doses but also predicts attainable yields, ensuring efficient and sustainable crop management.

Methodology

The basic data which is required for

formulating fertilizer recommendation for targeted yield are-

1. Nutrient requirement (NR) in kg/quintal of produce
2. Percentage contribution from the soil available nutrient (CS)
3. Percentage contribution from the applied fertilizer nutrient (CF)
4. Percentage contribution from organic source (CFYM/ CVc)

The above-mentioned parameters are calculated as:

$$\text{Nutrient requirement (NR) For one quintal produce (kg q}^{-1}\text{)} = \frac{\text{Total uptake of nutrients (kg ha}^{-1}\text{)}}{\text{Total biomass yield (q ha}^{-1}\text{)}}$$

$$\text{Per cent contribution from soil (Cs)} = \frac{\text{Total uptake of nutrients in control plot (kg ha}^{-1}\text{)}}{\text{Soil test value (STV) of nutrient in control plot (kg ha}^{-1}\text{)}} \times 100$$

$$\text{Per cent contribution from fertilizer (Cf)} = \frac{\text{Total uptake in fertilized plot (kg ha}^{-1}\text{) - (STV of nutrient in fertilized plot (kg ha}^{-1}\text{) x CS}}{\text{Fertilizer dose (kg ha}^{-1}\text{)}} \times 100$$

$$\text{Per cent contribution from organic source (Cfym/ Cv)} = \frac{\text{Total uptake in FYM/Vc plot (kg ha}^{-1}\text{) - (STV of nutrient in FYM/Vc treated plot (kg ha}^{-1}\text{) x CS}}{\text{Nutrient added through FYM/Vc (kg ha}^{-1}\text{)}} \times 100$$

STCR experimentation utilizes two primary methods : the Deductive Approach, which draws general inferences by selecting multiple sites with varying natural fertility and the Inductive Approach. The Inductive Approach is preferred as it deliberately creates fertility variations within a single field, minimizing variables like soil type, climate and management practices.

STCR experimentation is conducted under three phases -

A. Fertility Gradient Development : A representative field is divided into strips where varying doses of N, P and K are applied to create a fertility range from low to high. A short-duration exhaust crop is then grown to allow for nutrient transformation and biological stabilization across these strips.

B. Test Crop Cultivation and Analysis: After the exhaust crop is harvested, strips are divided into sub-plots receiving specific N, P, K and FYM treatments. Before sowing the test crop, soil samples are analyzed for nutrient availability. Upon maturity, grain and straw yields are recorded alongside total nutrient uptake to establish calibration equations.

NR, CS, CF and CFYM were calculated with the help of soil and applied fertilizer nutrient, crop yield and nutrient uptake of grain and straw. Equations for fertilizer requirement of nitrogen, phosphorus and potassium for targeted yield are worked out as follows:-

Fertilizer requirement equations for nutrients through use of chemical fertilizer are worked out as -

FN= (NR/CF) ×100 T - (CS/CF) × SN FP= (NR/CF) ×100 T - (CS/CF) × SP

FK= (NR/CF) ×100 T - (CS/CF) ×SK

Fertilizer requirement equations for nutrients through conjoint use of chemical fertilizer and FYM are worked out as -

FN = (NR/CF*) x 100 T - (CS/CF*) x SN - (CFYM/CF*) x M FP = (NR/CF*) x 100 T - (CS/CF*) x SP - (CFYM/CF*) x M

FK= (NR/CF*) x 100 T - (CS/CF*) x SK - (CFYM/CF*) x M

Where, FN = Fertilizer nitrogen (kg N ha^{-1}), FP = Fertilizer phosphorus (kg P ha^{-1}), F = Fertilizer potassium (kg K ha^{-1}), NR = Nutrient requirement of nitrogen, phosphorus and potassium CF = Percent contribution of concerned nutrient from fertilizer, CF* = Percent contribution of concerned nutrient from FYM, CS = Percent contribution of concerned nutrient from soil CFYM/ CVc = Percent contribution of concerned nutrient from FYM/ Vermicompost, T = Targeted yield (q ha^{-1}), SN = Soil test value for available nitrogen (kg ha^{-1}), SP = Soil test value for available phosphorus (kg ha^{-1}), SK = Soil test value for available potassium (kg ha^{-1}) and M = Concerned nutrient content in organic matter.

Then, statistical analysis was carried out and target yield equation was developed by fitting up of multiple regression equation

C. Verification or follow up trial : The target yield equation developed is then verified at different locations for validity of the equation and target yield.

Findings

1. Derivation of soil test crop response equation with farm yard manure

Agilo *et al*. (2021) developed soil test crop response (STCR) equations under an Integrated Plant Nutrition System (IPNS) in the western agro-climatic zone of Tamil Nadu during 2020-2021 to formulate fertilizer prescription equations for tomato (*Solanum lycopersicum* L.) grown on Alfisols under drip fertigation. The equations were derived using Ramamoorthy's inductive-cum-targeted yield model. The nutrient requirement to produce one quintal of tomato fruits was estimated as 0.22 kg N, 0.11 kg P_2O_5 and 0.27 kg K_2O. The percentage contribution of nutrients from soil (Cs) was 37.93% N, 46.73% P_2O_5 and 29.53% K_2O, while the contribution from fertilizers (Cf) was 47.84% N, 31.12% P_2O_5 and 74.13% K_2O. Two organic nutrient sources, farmyard manure (FYM) and biocompost, were also evaluated. The nutrient contribution from FYM was 38.36% N, 13.22% P_2O_5 and 52.17% K_2O, whereas biocompost contributed 43.34% N, 10.90% P_2O_5 and 57.00% K_2O. Arya and Gautam (2017) conducted soil test crop response correlation studies to develop fertilizer requirement equations for targeted tomato yields. The experiment evaluated the response of tomato to combinations of three levels of FYM (0, 10 and 20 t ha^{-1}), four nitrogen levels (0, 75, 150 and 225 kg ha^{-1}), four phosphorus levels (0, 45, 90 and 135 kg P_2O_5 ha^{-1}) and four potassium levels (0, 45, 90 and 135 kg K_2O ha^{-1}) under varying soil fertility conditions. The nutrient requirement for producing one quintal of tomato fruit was found to be 0.58 kg N, 0.11 kg P and 0.55 kg K. The percentage contribution from soil was 45.22% N, 66.08% P and 48.61% K, while FYM contributed 22.29% N, 30.46% P and 30.96% K. The contribution from chemical fertilizers was 67.84% N, 69.98% P and 134.37% K and the combined application of chemical fertilizers with FYM resulted in contributions of 72.55% N, 76.98% P and 140.67% K. Ayushi *et al*. (2022) conducted a soil test-based study during 2016-2017 on Mollisols at the Norman E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, using the Soil Test Crop Response (STCR) approach under an integrated plant nutrient supply system. The study aimed to develop fertilizer recommendation equations for achieving targeted yields of finger millet. Field experimental data were used to estimate key parameters, including nutrient requirement per quintal of grain and the relative contribution of nutrients from soil, fertilizers and farmyard manure (FYM). The results revealed that finger millet exhibited a greater response to nitrogen (N), phosphorus (P) and potassium (K) when chemical fertilizers were integrated with FYM compared to the application of NPK alone. The contribution of nutrients from FYM applied at 5 t ha^{-1} was 21.84% for N, 4.56% for P and 56.84% for K. To achieve a yield target of 40 q ha^{-1}, the required fertilizer doses were 33.74 kg N, 6.04 kg P and 24.27 kg K ha^{-1} when combined with 5 t ha^{-1} FYM, based on soil test values of 125 kg ha^{-1} $KMnO_4$-N, 15 kg ha^{-1} Olsen-P and 125 kg ha^{-1} NH_4OAc-K. The integrated use of fertilizers with FYM resulted in fertilizer savings of 24.4% for N, 18.8% for P and 45.2% for K compared to NPK alone. Furthermore, the reduction in fertilizer requirement increased with higher soil fertility levels. Balamurugan *et al*. (2021) carried out field experiments during 2017-2018 on Udic Haplustalf soils to develop fertilizer prescription equations (FPEs) for chrysanthemum under an Integrated Plant Nutrient System (IPNS). Fertilizer prescription equations were formulated for targeted flower yields under both NPK alone and IPNS by estimating essential parameters. The nutrient requirement to produce one quintal (100 kg) of chrysanthemum flowers was 0.83 kg N, 0.50 kg P_2O_5 and 1.21 kg K_2O. The contribution of soil-available nutrients to total uptake was 46.94% for N, 52.05% for P and 47.08% for K. Fertilizer nutrient contribution was 41.03% for N, 46.53% for P_2O_5 and 76.95% for K_2O, following the order $K_2O > P_2O_5 > N$. The estimated contribution from FYM was 27.39% N, 32.10% P_2O_5 and 47.71% K_2O. The variation between targeted and actual yields remained within ±10%, confirming the reliability of the developed equations. These results demonstrate that the inductive-cum-targeted yield approach offers a robust framework for maintaining soil fertility, enhancing productivity and improving nutrient use efficiency under precision farming systems. Basavaraja *et al*. (2011) conducted a field experiment during the *kharif* season of 2008-2009 on red soils (Kandic Paleustalfs) at the Zonal Agricultural Research Station, GKVK, Bengaluru, to develop targeted yield equations for carrot. Three fertility gradients were established based on soil-available NPK and carrot was used as the test crop in the main experiment. Data on initial soil fertility, root yield and NPK uptake were utilized to derive key parameters. The nutrient requirement to produce one quintal of carrot roots was 0.76 kg N, 0.42 kg P_2O_5 and 0.78 kg K_2O. The percentage contribution from fertilizers was 72.37% for N, 84.24% for P_2O_5 and 90.24% for K_2O, while soil contribution accounted for 28.55% N, 36.56% P_2O_5 and 59.29% K_2O. The contribution from organic matter was relatively small, amounting to 0.16% N, 0.12% P_2O_5 and 0.46% K_2O. These parameters were used to formulate fertilizer adjustment equations for achieving targeted carrot yields.

Basavaraja *et al*. (2016) conducted field experiments on Typic Rhodustalf soils of Mandya district (Agro-climatic Zone 6), Karnataka, using the inductive-cum-targeted yield model to quantify fertilizer requirements for rice under puddled conditions. Soil test crop response correlations were used to estimate nutrient requirement per quintal of grain, along with the percentage contribution of nutrients from soil, fertilizers and organic matter. Based on these parameters, fertilizer prescription equations were developed under an integrated plant nutrient system and subsequently validated under aerobic conditions within the same zone. The results showed significantly higher grain yield (65.73 q ha^{-1}) under the STCR-based integrated approach with a yield target of 75 q ha^{-1}. Improved agronomic nutrient use efficiency for N, P and K was also observed. However, the highest value-cost ratio (VCR) was recorded under the STCR-based inorganic approach with a 50 q ha^{-1} target, attributed to lower fertilizer application rates and reduced input costs in the absence of FYM. Beena *et al.* (2018) conducted field experiments on Ultisols at the STCR research field of Kerala Agricultural University, Thrissur, employing an integrated plant nutrient management system based on the STCR approach for vegetable cowpea. Soil test data, pod yield and nutrient uptake were used to estimate essential parameters, including nutrient requirement per tonne of pod yield and the contribution of nutrients from soil, fertilizers and FYM. The nutrient requirement for producing one tonne of cowpea pods was 10.82 kg N, 0.52 kg P_2O_5 and 8.00 kg K_2O. The percentage contribution from soil, fertilizers and FYM was 12.85%, 14.28% and 0.65% for N; 10.53%, 0.71% and 0.55% for P_2O_5 and 6.26%, 2.58% and 0.84% for K_2O, respectively. Using these parameters, a fertilizer dose ready-reckoner was prepared for varying soil fertility levels and targeted yields under both NPK alone and NPK combined with FYM. Bhatt *et al.* (2020) conducted a field experiment during the *kharif* season of 2018-19 at the N. E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, on Mollisols to develop fertilizer recommendations for brinjal using the Soil Test Crop Response (STCR) approach. In the initial phase, an artificial fertility gradient was established to create soil heterogeneity. In the second phase, brinjal response to graded combinations of farmyard manure (FYM) at three levels (0, 10 and 20 t ha^{-1}) and nitrogen, phosphorus and potassium fertilizers at four levels each was evaluated across fertility strips using a fractional factorial (Latin square type) design. Based on soil test values, nutrient uptake and yield data, basic parameters were computed and fertilizer adjustment equations were developed. These equations facilitate the estimation of fertilizer requirements for *kharif* brinjal under varying soil fertility conditions and targeted yield levels while considering farmers' economic constraints.

Bhavya *et al.* (2023) emphasized that fertilizer recommendations should be based on crop yield response, nutrient requirements, indigenous nutrient supply and the fate of applied fertilizers in soil. In this context, field experiments were conducted at the University of Agricultural Sciences, Bengaluru, from *kharif* 2013 to 2015 to develop targeted yield equations for carrot. Soil test data, yield and nitrogen (N), phosphorus (P) and potassium (K) uptake were used to estimate nutrient requirement and the contribution of nutrients from fertilizers, soil and organic manure. The nutrient requirement to produce one quintal of carrot was 0.76 kg N, 0.42 kg P_2O_5 and 0.79 kg K_2O. Fertilizer contribution was 72.37%, 84.24% and 90.34% for N, P_2O_5 and K_2O, respectively, while soil contribution was 28.55%, 36.56% and 59.29%. The contribution from FYM was relatively low. The STCR-based equations performed better than the soil test laboratory and general recommended dose approaches. Coumaravel *et al.* (2013) conducted STCR correlation studies on maize under an Integrated Plant Nutrition System (STCR-IPNS) on Typic Rhodustalf soils of Tamil Nadu using the inductive-cum-targeted yield model. Basic parameters such as nutrient requirement and the contribution of nutrients from soil, fertilizers and FYM were derived from field data. Based on these parameters, fertilizer prescription equations and ready reckoners were developed for different soil test values and yield targets. Application of FYM at 12.5 t ha^{-1} resulted in fertilizer savings of 40 kg N, 20 kg P_2O_5 and 26 kg K_2O and fertilizer reduction increased with higher soil nutrient availability. Jyothi *et al.* (2020) conducted a field experiment during 2014-2015 at the Sugarcane Research Station, Vuyyur, Krishna district, Andhra Pradesh, to develop STCR-based targeted yield equations for ratoon sugarcane. The results showed that the percentage contribution of nutrients from soil (Cs) to total nutrient uptake was 106.70% for available N, 79.20% for available P and 52.48% for available K. Soil contribution was comparatively higher for nitrogen than for phosphorus and potassium. The contribution from fertilizer nutrients (Cf) to total uptake was 22.88% for N, 66.51% for P_2O_5 and 112.20% for K_2O, following the order $K_2O > P_2O_5 > N$. The percentage contribution from FYM was 75.76% N, 20.79% P_2O_5 and 49.97% K_2O, indicating a higher contribution of nitrogen followed by potassium and phosphorus. The response yardstick recorded was 5.31 kg kg^{-1} and soil test-based targeted yield equations were successfully developed. Sharma *et al*. (2015) carried out STCR experiments on rice in the Bastar Plateau agroclimatic zone of Chhattisgarh during 2009-2011 to establish relationships among soil fertility, plant nutrient uptake and fertilizer application. The soils were poor to medium in available nitrogen and phosphorus and medium to high in potassium. Based on nutrient requirement and nutrient contribution from soil, fertilizers and FYM, optimal fertilizer doses were derived and validated for yield targets of 5.0 and 6.0 t ha^{-1}. The achieved yields were within ±10% of the targets, demonstrating the effectiveness of soil test-based fertilizer recommendations.

Mahajan *et al*. (2013) conducted STCR-IPNS studies on wheat grown on Inceptisols at New Delhi using Ramamoorthy's inductive-cum-targeted yield model. After establishing fertility gradients for nitrogen, phosphorus and sulphur, graded levels of fertilizers and FYM were applied. Soil and plant analysis data were used to compute basic parameters required for developing nutrient prescription equations. The nutrient requirement per quintal of wheat grain was 2.26 kg N, 0.40 kg P and 0.54 kg S. Soil, fertilizer and FYM contributed substantially to total nutrient uptake and fertilizer prescription equations and ready reckoners were developed for a range of soil test values and yield targets under both NPS alone and IPNS. Ghube *et al*. (2017) conducted STCR-IPNS studies on Inceptisols (Vertic Haplustepts) at Rahuri, Maharashtra, to develop fertilizer prescriptions for pre-seasonal sugarcane ratoon using the inductive-cum-targeted yield model. Maize was used as the gradient crop for plant cane, followed by sugarcane ratoon as the test crop. Based on soil test values, yield, nutrient uptake and applied inputs, basic parameters were computed. The nutrient requirement to produce one tonne of millable cane was 1.56 kg N, 0.58 kg P and 1.04 kg K. Fertilizer prescription equations were developed for different soil fertility levels and yield targets under both NPK alone and integrated nutrient management with FYM. Soil test crop response (STCR) correlation studies conducted by Jadhav *et al*. (2013) aimed to develop yield-targeted fertilizer prescription equations for tomato variety Dhanashree under an Integrated Plant Nutrition System (IPNS) on Entisols. Fertilizer adjustment equations were derived using Ramamoorthy's inductive-cum-targeted yield model. The nutrient requirement for producing one tonne of tomato fruit was 2.40 kg N, 0.70 kg P_2O_5 and 3.10 kg K_2O. The contribution of nutrients from soil and fertilizers was estimated to be 21.0% and 45.52% for nitrogen, 75.25% and 18.25% for phosphorus and 15.12% and 60.03% for potassium, respectively. In the presence of FYM, fertilizer contribution increased to 58.12% for nitrogen, 28.22% for phosphorus and 90.12% for potassium. The nutrient contribution from FYM alone was 12.25% for nitrogen, 6.13% for phosphorus and 15.22% for potassium. Jhinkwan *et al*. (2021) carried out a field experiment during 2018-19 to optimize integrated nutrient recommendations for forage oats (*Avena sativa* L.) grown on a Mollisol of Uttarakhand using the STCR approach. The experiment followed the technical guidelines of the All India Coordinated Research Project on Soil Test Crop Response Correlation. The study evaluated the response of forage oats to combinations of three FYM levels (0, 5 and 10 t ha^{-1}), four nitrogen levels (0, 40, 80 and 120 kg N ha^{-1}), four phosphorus levels (0, 30, 60 and 90 kg P_2O_5 ha^{-1}) and four potassium levels (0, 20, 40 and 60 kg K_2O ha^{-1}) across varying soil fertility gradients. To produce one quintal of forage yield, oats required 0.27 kg N, 0.03 kg $P_2O_5$and 0.32 kg K_2O with FYM. The percent contribution of nutrients from soil was 71.4% for N, 33.7% for P_2O_5 and 59.9% for K_2O, while FYM contributed 73.0%, 7.51% and 90.4%, respectively. Chemical fertilizers contributed 89.6%, 50.8% and 302.7% and their combined application with FYM contributed 102.4%, 52.9% and 351.5% for N, P_2O_5 and K_2O, respectively.

Das *et al*. (2017) conducted on-farm trials during 2012-2014 under an autumn rice-winter rice cropping system across 21 farmers' fields in humid sub-tropical northeastern India. Results indicated that fertilizer recommendations based on the targeted yield precision model, both with and without IPNS components, resulted in significantly higher grain yield, additional yield advantages and increased net returns compared to farmers' practices and conventional fertilizer schedules. Achievement of preset yield targets exceeded 100% in autumn rice and ranged from 96% to 106% in winter rice. The nutrient requirement for producing 100 kg of grain was 2.39 kg N, 0.84 kg P_2O_5 and 2.25 kg K_2O for autumn rice and 1.82 kg N, 0.33 kg P_2O_5 and 1.94 kg K_2O for winter rice. Soil contributed 15.5% and 28.5% of nitrogen uptake in autumn and winter rice, respectively, while fertilizer contributed 35.3% and 42.3%. Phosphorus contribution from soil and fertilizer was 17% and 28.8% in autumn rice and 46.2% and 21.2% in winter rice. Potassium contribution from soil was 26.6% and 65.4%, whereas fertilizer contributed 49.1% and 51.5% to autumn and winter rice, respectively. FYM contributed 6.8%, 4.7% and 7.8% of N, P_2O_5 and K_2O to autumn rice and 9.9%, 2.7% and 12.2% to winter rice. Katharine *et al*. (2014) evaluated fertilizer dose optimization using the inductive-cum-targeted yield model for transgenic cotton grown under drip fertigation on an Inceptisol. The nutrient requirement to produce one quintal of seed cotton was 4.43 kg N, 2.20 kg P_2O_5 and 4.83 kg K_2O. Among the nutrients, K_2O requirement was the highest, being 1.09 times greater than nitrogen and 2.20 times greater than phosphorus. Soil contribution to total uptake was 24.65% for N, 48.95% for P and 11.06% for K. Fertilizer contribution accounted for 52.01% N, 49.89% P_2O_5 and 73.35% K_2O uptake. FYM contributed 38.19% N, 16.43% P_2O_5 and 40.35% K_2O, indicating the highest contribution from potassium followed by nitrogen and phosphorus. Batabyal *et al*. (2015) conducted STCR-IPNS studies in an Inceptisol of West Bengal during 2008-2010 using radish as the test crop, following Ramamoorthy's inductive-cum-targeted yield approach. The experiment included four NPK fertilizer levels and three FYM levels across three fertility gradients, each consisting of 21 plots. Fertilizer adjustment equations were developed for different yield targets with and without FYM. The nutrient requirement to produce 100 kg of radish was 1.40 kg N, 0.17 kg P and 2.8 kg K. Fertilizer contribution to total nutrient uptake was substantially higher than that from soil and FYM. Application of FYM at 10 t ha^{-1} along with NPK fertilizers resulted in savings of 15 kg N ha^{-1}, 1.8 kg P ha^{-1} and 5.0 kg K ha^{-1}.

Vijayakumar *et al*. (2017) developed fertilizer prescription equations for rice under SRI cultivation using the STCR-IPNS approach on non-calcareous sandy loam soils of Lithic Haplustep at the Regional Research Station, Paiyur, Tamil Nadu, during *Kharif* 2013. Fertilizer recommendations were validated during *Kharif* 2014 for target yields ranging from 6 to 9 t ha^{-1}. The nutrient requirement per quintal of grain yield was 1.57 kg N, 0.71 kg P_2O_5 and 1.98 kg K_2O. Soil, fertilizer and organic manure contributed 16.18%, 44.97% and 33.29% of nitrogen; 51.64%, 42.89% and 12.88% of phosphorus; and 49.48%, 90.46% and 39.14% of potassium, respectively. The higher contribution of potassium from fertilizer was attributed to interaction effects of higher N and P doses and priming effects of starter potassium. Luthra *et al*. (2022) conducted a field experiment during 2017-18 at the Crop Research Centre, G.B.P.U.A.&T., Pantnagar, to develop fertilizer adjustment equations for targeted yield of hybrid maize (*Zea mays* L.) using the STCR approach. The crop response to four levels of N, P and K and two FYM levels under different fertility gradients was assessed. Nutrient requirements were 2.17 kg N, 0.46 kg P and 2.74 kg K per quintal of grain yield. Fertilizer contribution was 58.2%, 62.7% and 420.4% for N, P and K, respectively, while soil contributed 33.1%, 26.8% and 22.7%. FYM contributed 45.2% N, 14.4% P and 239.4% K, whereas combined fertilizer and FYM application contributed 62.4%, 63.5% and 427.6%. Integration of FYM with fertilizers resulted in higher nutrient response and an average fertilizer saving of 24.52 kg N ha^{-1}, 7.11 kg P ha^{-1} and 3.50 kg K ha^{-1} in Mollisols. Sugumari *et al*. (2021) emphasized that balanced crop nutrition coupled with efficient irrigation is essential for achieving profitable bulb yield in shallow-rooted, nutrient-exhaustive aggregatum onion. To develop fertilizer prescription equations (FPEs) for aggregatum onion under drip fertigation using the Soil Test Crop Response (STCR) approach, a field experiment was conducted on the Palaviduthi soil series. The experiment consisted of 15 treatments, including absolute control (T_1), blanket recommendation (60:60:30) + FYM @ 12.5 t ha^{-1} (T_2), STCR-based NPK fertilizer recommendations for targeted yields of 14 t ha^{-1} (T_3), 15 t ha^{-1} (T_4) and 16 t ha^{-1} (T_5), FYM @ 6.25 (T_6) and 12.5 t ha^{-1} (T_7), STCR-NPK + FYM @ 12.5 t ha^{-1} for targeted yields of 14 t ha^{-1} (T_8), 15 t ha^{-1} (T_9) and 16 t ha^{-1} (T_{10}), biocompost @ 2.5 t ha^{-1} (T_{11}) and 5 t ha^{-1} (T_{12}) and STCR-NPK + biocompost @ 5 t ha^{-1} for targeted yields of 14 t ha^{-1} (T_{13}), 15 t ha^{-1} (T_{14}) and 16 t ha^{-1} (T_{15}). Among the treatments, T_{10} recorded superior performance over others. Basic parameters were computed using experimental data on total nutrient uptake, initial soil fertility status and applied fertilizer doses. Aggregatum onion (var. CO-4) required 0.43 kg N, 0.32 kg P_2O_5 and 0.45 kg K_2O to produce one quintal of bulb yield. The percent contribution of nutrients from soil and fertilizer was 14.01 and 54.57 for N, 35.11 and 50.50 for P_2O_5 and 12.69 and 70.12 for K_2O, respectively. The contribution of N, P_2O_5 and K_2O from FYM and biocompost was 41.02, 16.23 and 41.53% and 47.98, 15.87 and 49.56%, respectively. Based on these parameters, fertilizer prescription equations were formulated for aggregatum onion under drip fertigation in the Palaviduthi soil series.

Raghuveer *et al*. (2017) investigated the influence of fertilizer application and soil test values on yield and nutrient status of garlic with the objective of achieving targeted and maximum economic yield. The nutrient requirement for garlic was found to be 2.23 kg N, 0.87 kg P_2O_5 and 2.02 kg K_2O ha^{-1}. The percent nutrient utilization efficiencies from soil and fertilizer sources were 12 and 41 for nitrogen, 66 and 36 for phosphorus and 26 and 51 for potassium, respectively. The contribution of N, P_2O_5 and K_2O from FYM was 18, 68 and 54%, respectively. Utilization efficiency from fertilizer sources was 34% for nitrogen, 23% for phosphorus and 32% for potassium. Rawat *et al*. (2015) conducted STCR studies to optimize fertilizer recommendations for okra grown on Mollisols of Uttarakhand. The nutrient requirement per quintal of okra was 0.70 kg N, 0.21 kg P and 0.72 kg K. The percent contribution from soil was 35.00, 72.0 and 29.0 for N, P and K, respectively. Fertilizer contribution in the absence and presence of FYM was 26.0 and 29.0 for nitrogen, 19.0 and 20.0 for phosphorus and 51.0 and 58.0 for potassium, respectively. The contribution of N, P and K from FYM was 5.50, 11.9 and 7.0%, respectively. Higher nutrient contribution was observed with fertilizer application along with FYM, likely due to enhanced microbial activity and increased nutrient availability. Udayakumar and Santhi (2017) conducted STCR-IPNS experiments based on the targeted yield concept for pearl millet on an Inceptisol in the Western Zone of Tamil Nadu during 2015-16. The nutrient requirement was 2.87 kg N, 1.27 kg P_2O_5 and 2.59 kg K_2O per quintal. Soil contribution was 23.48, 32.76 and 11.10%, fertilizer contribution was 47.45, 45.59 and 78.52% and organic manure contribution was 38.03, 19.28 and 37.58% for N, P_2O_5 and K_2O, respectively. Using these parameters, fertilizer prescription equations and ready reckoners were developed. Application of FYM @ 12.5 t ha^{-1} resulted in a reduction of 40, 24 and 28 kg ha^{-1} of fertilizer N, P_2O_5 and K_2O, respectively. Sakarvadia *et al*. (2016) conducted STCR studies on pigeon pea in the Junagadh region of Gujarat during *kharif* 2012 and 2013. The nutrient requirement to produce one quintal of seed yield was 6.09 kg N, 1.98 kg P_2O_5 and 1.78 kg K_2O. Soil and fertilizer contribution was 27.22 and 86.88% for nitrogen, 60.59 and 37.65% for phosphorus and 7.46 and 14.10% for potassium, respectively. Fertilizer contribution in the presence of FYM was 114% for nitrogen, 45.51% for phosphorus and 17.39% for potassium. FYM contributed 15.38% N, 4.97% P and 5.27% K. For achieving 15 q ha^{-1} yield, fertilizer doses of 37 kg N, 30 kg P_2O_5 and 81 kg K_2O ha^{-1} along with 5 t FYM ha^{-1} were recommended.

Sellamuthu *et al*. (2019) quantified fertilizer requirements for big onion on Typic Ustropept soils of Tamil Nadu using the inductive-cum-targeted yield model. Nutrient requirement and contributions from soil, fertilizer and FYM were estimated and fertilizer prescription equations were developed under IPNS. Application of FYM @ 12.5 t ha^{-1} resulted in fertilizer savings of 40 kg N, 20 kg P_2O_5 and 33 kg K_2O. Singh *et al*. (2018) conducted STCR studies on lentil during rabi 2017-18 on an Inceptisol at Banaras Hindu University. The nutrient requirement was 4.99 kg N, 0.90 kg P_2O_5 and 2.16 kg K_2O per quintal. Soil, fertilizer and FYM contribution was 29.1, 105.1 and 7.3% for N; 65.3, 38.7 and 2.4% for P_2O_5; and 14.1, 58.5 and 4.3% for K_2O, respectively. Fertilizer prescription equations were developed for lentil var. HUL-57TL. Singh *et al*. (2020) conducted STCR-IPNS studies on potato during rabi 2018-19 on Inceptisols of Raigarh, Chhattisgarh. The nutrient requirement per quintal of tuber yield was 0.42 kg N, 0.11 kg P and 0.45 kg K. Fertilizer contribution was 31.27, 22.06 and 82.93%, while soil contribution was 14.39, 48.94 and 17.78% for N, P and K, respectively. FYM contribution was 8.33, 3.50 and 19.60%. Based on these parameters, fertilizer prescription equations were developed. Singh *et al*. (2020) also conducted STCR studies on coriander during rabi 2018-19 on an Inceptisol at Banaras Hindu University. The nutrient requirement was 4.83 kg N, 0.80 kg P_2O_5 and 4.10 kg K_2O per quintal. Soil, fertilizer and FYM contribution was 21.2, 56.6 and 9.6% for N; 60.8, 39.3 and 2.38% for P_2O_5; and 25.5, 114.0 and 5.22% for K_2O, respectively. These equations were validated under farmer field conditions and found suitable for Eastern Uttar Pradesh. Suresh and Santhi (2019) conducted field experiments during 2016-17 at Manickapuram village in Theni District, Southern Zone of Tamil Nadu, to study the impact of the inductive approach (artificial fertility gradient) on soil fertility, nutrient uptake and fodder yield of sorghum (var. CO-30). Subsequently, Soil Test Crop Response (STCR) correlation studies under the Integrated Plant Nutrition System (IPNS) were carried out for achieving desired yield targets of maize on Vertisols. The soil profile characteristics of the experimental site were described in detail. An artificial fertility gradient was created by dividing the experimental field into three equal strips and applying graded levels of fertilizers in the form of urea, single superphosphate and muriate of potash to strip I ($N_0P_0K_0$), strip II ($N_1P_1K_1$) and strip III ($N_2P_2K_2$). The N_1 level was fixed based on the blanket recommendation for fodder sorghum, while P_1 and K_1 levels were determined based on the phosphorus (100 kg ha^{-1}) and potassium (80 kg ha^{-1}) fixing capacities of the soil. Sorghum (var. CO-30) was grown as a gradient crop and green fodder yield was recorded at harvest. Plant samples were collected and analyzed for N, P and K content and nutrient uptake was computed. The results confirmed that graded application of fertilizer N, P_2O_5 and K_2O significantly influenced soil fertility status, nutrient uptake and green fodder yield of sorghum. The subsequent STCR-IPNS studies on hybrid maize revealed that the nutrient requirement (NR) for maize was 2.08 kg N, 0.73 kg P_2O_5 and 1.38 kg K_2O q^{-1}. The percent contribution from soil (Cs) was 43.01, 44.03 and 9.17; from fertilizers (Cf) was 55.00, 49.83 and 76.99; and from organic manure (Co) was 49.01, 19.71 and 39.83 for N, P_2O_5 and K_2O, respectively. Using these basic parameters (NR, Cs, Cf and Co), fertilizer prescription equations were developed and a ready reckoner of fertilizer doses was prepared for different soil test values and yield targets of maize on Vertisols. The study further indicated that application of FYM @ 12.5 t ha^{-1} (with 25% moisture and 0.54, 0.26 and 0.53% NPK, respectively) resulted in a reduction of 45 kg N, 22 kg P_2O_5 and 32 kg K_2O ha^{-1} from the recommended fertilizer doses for maize. Critical limits of soil-available N, P and K were also established using nomograms.

Upadhyay *et al*. (2017) conducted Soil Test Crop Response correlation experiments on barley at Pantnagar (29°N latitude, 79°29 E longitude) in the Tarai region of Uttarakhand during rabi 2010-11. Fertilizer adjustment equations were developed to determine optimum fertilizer requirements for achieving different yield targets. The nutrient requirement per quintal of barley grain yield was 2.57 kg N, 0.47 kg P and 2.32 kg K. The percent contribution of N, P and K from soil was 32.96, 77.42 and 34.61; from FYM was 15.4, 8.1 and 19.7; from fertilizers was 86.13, 34.45 and 138.6; and from fertilizer combined with FYM was 88.23, 40.3 and 152.5, respectively. Fertilizer adjustment equations and ready reckoners were calibrated for achieving a yield target of 35 q ha^{-1} of barley based on the targeted yield concept. Tripathi *et al*. (2020) conducted field experiments during 2013-14 and 2014-15 on marigold (*Tagetes* spp., var. Pusa Narangi) and urd (Vigna mungo, var. Pant Urd-31) using Ramamoorthy's inductive methodology to quantify soil test-based integrated fertilizer prescriptions for targeted yields. The experiments were conducted at the Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar. The results indicated that 1.06 kg N, 0.34 kg P and 1.32 kg K were required to produce one quintal of marigold flowers in Mollisols of Pantnagar. The percent contribution from soil for marigold was 26.23, 54.03 and 42.02 for N, P and K, respectively, while the contribution from fertilizer with FYM was 98.35, 40.25 and 168.68. Fertilizer prescription equations and nomograms were developed for a range of soil test values and yield targets. For urd, the nutrient requirement to produce one quintal of grain was 3.18 kg N, 0.63 kg P and 2.54 kg K. The percent contribution from soil was 38.15, 72.61 and 36.51, while the contribution from fertilizer with FYM was 187.65, 15.88 and 96.08 and from fertilizer without FYM was 169.81, 17.19 and 94.98 for N, P and K, respectively. Tripathi *et al*. (2018) conducted a two-phase STCR field experiment during spring 2014-15 at the Norman E. Borlaug Crop Research Centre, Pantnagar. In the first phase, an artificial soil fertility gradient was developed by dividing the field into three strips: strip I (no fertilizer), strip II (100 kg ha^{-1} each of N, P_2O_5 and K_2O) and strip III (200 kg ha^{-1} each of N, P_2O_5 and K_2O), followed by cultivation of sorghum (var. Pant Chari-7) as an exhaust crop. In the second phase, urd bean (var. Pant Urd-7) was grown as the test crop. The response of urd to three levels of FYM (0, 5 and 10 t ha^{-1}), four levels of nitrogen (0, 10, 20 and 30 kg ha^{-1}), phosphorus (0, 20, 40 and 60 kg ha^{-1}) and potassium (0, 30, 60 and 90 kg ha^{-1}) was studied. Soil organic carbon ranged from 0.22 to 0.75%, alkaline $KMnO_4$-extractable N from 112 to 178 kg ha^{-1}, Olsen's P from 12.20 to 20.02 kg ha^{-1} and NH_4OAc-extractable K from 100.2 to 178.85 kg ha^{-1}. Straw yield ranged from 64.93 to 233.76 q ha^{-1} and grain yield ranged from 17.26 to 181.72 q ha^{-1}. The nutrient requirement per quintal of urd grain was 3.18 kg N, 0.63 kg P and 2.54 kg K. The percent contribution from soil was 38.15, 72.61 and 36.51; from FYM was 78.34, 17.05 and 38.21; from chemical fertilizers was 169.81, 17.19 and 94.98; and from combined fertilizer and FYM application was 187.65, 15.88 and 96.08 for N, P and K, respectively.

Singh *et al*. (2021) conducted field investigations on direct-seeded rice (DSR) during the 2017 and 2018 rice-growing seasons at Pantnagar, Uttarakhand, to develop and validate STCR-based fertilizer recommendations and to compare STCR treatments with the general recommended dose (GRD). For producing 1 Mg of rice grain, the nutrient requirement was 2.01 kg N, 0.44 kg P and 3.06 kg K. The contribution from soil was 22.05, 37.34 and 41.48%; from FYM was 23.25, 28.34 and 16.80%; from fertilizer was 38.08, 49.93 and 252.98%; and from fertilizer with FYM was 44.83, 60.57 and 278.70% for N, P and K, respectively. The STCR approach, with or without FYM, significantly increased grain yield (20.2-32.3%), nutrient uptake, use efficiency and profitability compared to GRD at yield targets of 4.5 and 5.0 Mg ha^{-1}. Yadav *et al*. (2021) conducted STCR correlation studies to develop fertilizer adjustment equations for cabbage (var. Pusa Drum Head) under IPNS on Torripsamment soils during rabi 2013-14. The nutrient requirement for producing one quintal of cabbage yield was 0.31 kg N, 0.11 kg P_2O_5 and 0.68 kg K_2O. The percent contribution from soil and fertilizer was 19.90 and 17.70 for N, 31.11 and 11.93 for P and 30.13 and 53.50 for K, respectively. The organic nutrient contribution from FYM was 22.79, 12.45 and 27.19% for N, P and K. For achieving a yield of 20 t ha^{-1}, fertilizer requirements were estimated as 71.0 kg N, 52.1 kg P_2O_5 and 96.5 kg K_2O ha^{-1} along with 20 t FYM ha^{-1}, considering average soil test values of 100, 30 and 190 kg ha^{-1} of available N, P_2O_5 and K_2O, respectively.

2. Derivation of soil test crop response equation with vermicompost and other organic material

Patil *et al*. (2026) investigated fertilizer prescription for rabi onion using the Soil Test Crop Response (STCR) approach integrated with vermicompost and bio-fertilizer in Inceptisols. The field experiment was carried out during *rabi* 2021 at the STCR Research Farm, Department of Soil Science, Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra. The study followed an integrated nutrient management (INM) strategy based on the STCR concept to develop fertilizer recommendation equations for rabi onion. Soil test values, onion bulb yield and nitrogen (N), phosphorus (P) and potassium (K) uptake were used to compute four basic parameters, namely nutrient requirement (NR) for producing one quintal of onion bulb, contribution from fertilizer (Cf%), contribution from soil (Cs%) and contribution from vermicompost (CVc%). The results indicated that 0.39 kg N, 0.05 kg P_2O_5 and 0.28 kg K_2O were required to produce one quintal of onion bulb yield. The respective contributions from soil, fertilizer, vermicompost (Vc) and vermicompost combined with bio-fertilizer (Bf) were 31%, 47%, 61% and 62% for N; 43%, 13%, 14% and 20% for P_2O_5; and 11%, 62%, 73% and 77% for K_2O. Using these parameters, ready-reckoner tables for inorganic fertilizer doses were prepared for different soil test values and yield targets under NPK alone, NPK + Vc and NPK + Vc + Bf treatments. Madhavi *et al.* (2020) conducted soil test crop response-based integrated plant nutrition system (STCR-IPNS) studies over three years on Alfisols of Unified Andhra Pradesh, Southern India, during the summer seasons from 2016 to 2018. The experiments followed the Inductive cum Targeted Yield Model to develop fertilizer prescriptions for sesame under field conditions. Basic parameters such as nutrient requirement (NR), contribution from soil (Cs), fertilizer (Cf) and vermicompost (CVC) were derived from field experimental data. Based on these parameters, fertilizer prescription equations were developed for NPK alone and IPNS across a range of soil test values and yield targets. The nutrient requirement to produce 100 kg of sesame seed was 10.20 kg N, 3.90 kg P_2O_5 and 5.22 kg K_2O, with nitrogen showing the highest requirement, followed by potassium and phosphorus. The nitrogen requirement was 2.62 times higher than phosphorus and 1.95 times higher than potassium. The percent contribution of nutrients from soil was 12.25% for N, 15.75% for P and 6.00% for K, while fertilizer contributions were 41.68%, 22.85% and 59.97%, respectively. Vermicompost contributed 9.87% N, 6.74% P and 18.65% K. The study confirmed that the Inductive cum Targeted Yield Model provides a robust framework for maintaining soil fertility, enhancing productivity and ensuring sustainable nutrient management.

Giri *et al.* (2017) conducted a field experiment on maize (Zea mays) variety 'DHM-117' during *kharif* 2012 on a semi-arid Alfisol at PJTSAU, Rajendranagar, Telangana, India. The experiment comprised 21 treatments involving different levels of N, P_2O_5, K_2O and vermicompost. The nutrient requirement for producing one quintal of maize grain yield was 2.67 kg N, 1.64 kg P_2O_5 and 2.27 kg K_2O. The percent contribution from soil (Cs) was 21.6% for N, 85.2% for P_2O_5 and 11.3% for K_2O, whereas fertilizer contribution (Cf) accounted for 69.8% N, 100.1% P_2O_5 and 239.9% K_2O. The contribution from vermicompost (Cvc) was 47.5% for N, 59.0% for P_2O_5 and 51.1% for K_2O. Singh *et al.* (2022) carried out STCR correlation studies to develop targeted yield fertilizer prescription equations for wheat (*Triticum aestivum* L.) under the Integrated Plant Nutrition System (IPNS) at the Research Farm of Punjab Agricultural University, Ludhiana, during 2019-2021. Fertilizer recommendations under NPK alone and IPNS were developed using Ramamoorthy's Inductive cum Targeted Yield approach. The nutrient requirement for producing 100 kg of wheat grain was 2.06 kg N, 0.78 kg P_2O_5 and 1.95 kg K_2O. The contribution of nutrients from soil and fertilizer was 52.3% and 54% for N, 11.7% and 50% for P; and 20.2% and 20.6% for K, respectively. In addition, incorporation of rice residue contributed 42.0% N, 15.3% P and 26.0% K, resulting in enhanced nutrient uptake. Sreelatha *et al*. (2020) conducted STCR studies on ratoon sugarcane from 2009-10 to 2013-14 in clay loam Inceptisols at the Regional Agricultural Research Station, Anakapalle, Andhra Pradesh, with the objective of developing soil test-based fertilizer recommendations under IPNS for North Coastal Andhra Pradesh. Fertility gradient experiments using maize followed by test crop experiments with sugarcane (var. 2001A63) were conducted over two years. The nutrient requirement for producing one quintal of sugarcane during the first-year ratoon (2012-13) was 3.24 kg N, 0.90 kg P and 3.56 kg K, while during the second-year ratoon (2013-14) it was 3.32 kg N, 0.94 kg P and 46.65 kg K. Soil contribution for nitrogen was 32.92% in the first year and 33.84% in the second year, whereas fertilizer contribution was 77.81% and 78.71%, respectively. Organic manure (PMC) contributed 1.12% N in the first year and 4.12% in the second year. Soil phosphorus efficiency was 214.32% in the first year and 54.36% in the second year, with fertilizer contributing 87.62% and 89.38% and organic manure contributing 1.42% and 3.42%, respectively. Soil potassium contribution was 45.76% and 46.65% during the two years, while fertilizer contribution was 195.2% in the first year and 95.2% in the second year. Organic manure contribution to potassium was 1.46% and 4.46% in the respective years. The response yardstick values were 14.35 and 4.46 kg output per kg input during 2012-13 and 2013-14, respectively.

3. Validation of STCR equation through follow up trials

Margal *et al*. (2024) conducted a field experiment during the rabi season of 2022-23 to validate fertilizer prescription equations and to evaluate the effect of the Soil Test Crop Response (STCR) targeted yield approach on the growth and yield of rabi onion. The experiment was laid out in a randomized block design comprising ten treatment combinations, namely absolute control; generalized recommended dose of fertilizer (GRDF) at 100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} with FYM @ 25 t ha^{-1}; fertilizer application as per soil test; STCR target of 250 q ha^{-1} without vermicompost; STCR target of 300 q ha^{-1} without vermicompost; STCR target of 350 q ha^{-1} without vermicompost + biofertilizer; STCR target of 250 q ha^{-1} with vermicompost; STCR target of 300 q ha^{-1} with vermicompost; STCR target of 300 q ha^{-1} with vermicompost + biofertilizer; and vermicompost alone @ 5 t ha^{-1}. The results indicated that treatment T9 recorded significantly higher growth parameters, including number of leaves (8.56 and 11.52) and plant height (42.00 and 57.46 cm) at 40 and 80 days after transplanting (DAT), respectively. Higher chlorophyll content (41.30 and 51.84) was observed at 45 and 60 DAT. Yield attributes such as polar and equatorial diameter (6.36 and 9.48 cm), neck girth (4.94 cm) and bulb weight (64.09 g) were also significantly superior under T9. Consequently, treatment T_9 (STCR target of 300 q ha^{-1} with vermicompost + biofertilizer) produced the highest bulb yield of 363.67 q ha^{-1} with a percent deviation of 3.90%, along with a top yield of 67.18 q ha^{-1}. Eunice *et al*. (2023) evaluated STCR-based targeted yield equations for amaranthus (*Amaranthus tricolor* L.) in the southern laterite soils (AEU-8) of Kerala. The experiment was conducted in a randomized block design with four replications and five treatments, namely KAU organic POP (T_1), soil test-based KAU recommendation (T_2) and STCR-based targeted yield recommendations for 20, 22.5 and 30 tonnes ha^{-1} (T_3, T_4 and T_5). Nutrient management using STCR-based recommendations for a target yield of 25 tonnes ha^{-1} (T_5) resulted in significantly higher plant height, stem girth, leaf length, petiole length, leaf width, number of branches per plant, number of leaves per plant and root length at 30 and 60 DAS. Treatment T_5 also enhanced N, P and K content and uptake in leaf, shoot and root and performed significantly better than other treatments. The study concluded that the AICRP-STCR (2014) nutrient management equation for amaranthus can be effectively extended to the Ultisols of AEU-8 in Thiruvananthapuram district, Kerala. Rajamani *et al*. (2020) conducted validation experiments from 2015-16 to 2017-18 on Typic Rhodustalfs (Alfisols) at the Regional Agricultural Research Station, Palem, Nagarkurnool, Telangana, to verify targeted yield-based fertilizer prescription equations developed for hybrid castor. Eight treatments were evaluated, including blanket recommendation (100% RDF: 80:40:30 kg $N:P_2O_5:K_2O$ ha^{-1}), blanket + vermicompost @ 5 t ha^{-1}, STCR-NPK and STCR-IPNS for target yields of 25 and 30 q ha^{-1}, farmer's practice (40:20:0 kg $N:P_2O_5:K_2O$ ha^{-1}) and absolute control. The results showed that percent achievement of target yields was within ±10%, confirming the validity of the equations. STCR-NPK treatments recorded significantly higher seed and stalk yields than blanket recommendations, while STCR-IPNS treatments resulted in still higher yields and greater soil fertility build-up.

Reddy *et al*. (2022) developed and validated STCR and STCR-IPNS fertilizer prescription equations for maize using the Inductive cum Targeted Yield Model on Vertisols of northern Karnataka during *kharif* 2020-21. Fertilizer doses were computed for yield targets of 60, 80 and 100 q ha^{-1} based on soil test values and FYM contributions. Validation trials conducted during *kharif* 2021-22 at Dharwad and Belavatgi demonstrated that yield achievement was within ±10% of the targets. The STCR-IPNS treatment with a 100 q ha^{-1} target produced the highest grain yield at both locations and recorded higher economic returns and better post-harvest soil fertility status, confirming the suitability of the equations for Vertisols of Karnataka. Jadhav *et al*. (2009) studied the response of chickpea to combined application of STCR-based inorganic fertilizers and vermicompost on Inceptisols. Fertilizer application for a 25 q ha^{-1} yield target along with vermicompost @ 5 t ha^{-1} resulted in significantly higher grain and straw yields, nutrient uptake and micronutrient absorption compared to other treatments. Dhruw *et al*. (2023) validated STCR-based fertilizer prescriptions for rice (var. Rajeshwari) on farmers' fields in Kondagaon district, Chhattisgarh, during *kharif* 2020. The study confirmed that STCR-based fertilizer doses achieved yield targets of 50 and 60 q ha^{-1} within acceptable deviation limits and produced significantly higher grain and straw yields compared to farmers' practice and control. Gayathri *et al*. (2009) developed and validated STCR-IPNS fertilizer prescription equations for potato on Ultisols. Validation trials revealed more than 90% achievement of targeted yields, with STCR-IPNS at 40 t ha^{-1} recording higher response ratio and benefit-cost ratio, confirming the reliability of the model. Getahun *et al*. (2020) conducted on-farm verification trials of soil test-based phosphorus calibration for bread wheat in Ethiopia. Soil test-based P recommendations significantly improved grain yield and marginal rate of return compared to farmer's practice, demonstrating the effectiveness of site-specific fertilizer application. Goyal *et al*. (2020) evaluated STCR-IPNS targeted yield fertilizer models for wheat across 12 farmers' fields in Haryana. Targeted yields of 5.5 and 6.0 t ha^{-1} were achieved within ±10% deviation, with IPNS treatments recording higher productivity, profitability and benefit-cost ratios.

Kirankumar *et al*. (2019) validated STCR-IPNS fertilizer prescriptions for hybrid brinjal on

Typic Haplustepts of Andhra Pradesh. Target yields were achieved within ±10% variation and STCR-IPNS treatments resulted in higher yield, improved quality parameters and better economic returns compared to blanket recommendations and farmers' practice. Kokate *et al*. (2022) assessed the effect of STCR-based NPK application on gram productivity in Vertisols of Maharashtra. Application of STCR-based nutrients with vermicompost and zinc recorded superior growth and yield attributes compared to other treatments. Singh *et al*. (2017) validated STCR-INM fertilizer prescriptions for rice in eastern Uttar Pradesh. Yield targets of 4.5 and 5.0 t ha^{-1} were achieved within ±5% deviation, with STCR-INM producing higher yields, benefit-cost ratio and improved post-harvest soil fertility. Patel *et al*. (2020) conducted a field experiment during 2017-18 entitled "Verification trial of soil test-based fertilizer prescription model for wheat in Anand district of Gujarat." The experimental soil was loamy sand in texture. Verification trials were carried out at three locations in the Anand district. Fertilizer recommendations were worked out based on initial soil test values for different wheat yield targets (40, 50 and 60 q ha^{-1}) under NPK alone and NPK combined with FYM @ 10 t ha^{-1}. The targeted yield treatments (40, 50 and 60 q ha^{-1}), both with and without FYM, significantly increased grain yield, straw yield, nutrient uptake and soil fertility status. These treatments also resulted in higher value of produce, percentage achievement of yield targets, net returns over control and benefit-cost ratio at all locations compared to RDF. Among the treatments, STCR-based targeted yields (40, 50 and 60 q ha^{-1}) combined with FYM @ 10 t ha^{-1} were superior to STCR treatments without FYM in terms of grain yield, nutrient uptake and maintenance of soil fertility. Reddy *et al*. (2022) evaluated soil test-based fertilizer prescription as an approach to minimize over- or under-application of fertilizers, thereby enhancing crop productivity and fertilizer use efficiency. Field experiments on sugarcane plant crop were conducted for three consecutive years from 2017-18 to 2019-20 on Vertisols at the Regional Sugarcane and Rice Research Station, Rudrur, Nizamabad district, Telangana, to validate the Soil Test Crop Response (STCR) equations. Treatments included farmers' practice, recommended dose of fertilizers (RDF) and STCR-based fertilizer recommendations for a yield target of 110 t ha^{-1}. Fertilizer requirements for N, P and K were computed based on initial soil test values of individual locations. Results showed that STCR (110 t ha^{-1}) increased yield by 1.0% over blanket RDF and by 3.7% over farmers' practice. The targeted yield of 110 t ha^{-1} was achieved within a deviation of 5%. A net reduction in fertilizer requirement of P_2O_5 and K_2O by 41 kg and 37 kg ha^{-1}, respectively, was observed, resulting in a fertilizer cost saving of Rs. 2,275 per application per year. The benefit-cost ratio under STCR recommendations (2.30) was higher than that under farmers' practice (2.18). The fertilizer prescription equation developed for sugarcane was found to be suitable for achieving the targeted yield of 110 t ha^{-1}.

Santhi *et al*. (2002) conducted Soil Test Crop Response (STCR) correlation studies on aggregatum onion in red non-calcareous soils (Typic Ustropepts) of Coimbatore and developed fertilizer prescription equations under the Integrated Plant Nutrition System (IPNS). A ready reckoner of fertilizer doses was prepared for varying soil test values to achieve target bulb yields of 17 and 20 t ha^{-1}. Using these equations, verification trials were conducted on farmers' fields in Coimbatore district. The percentage achievement of the targeted yields exceeded 90%, indicating the validity of the fertilizer prescription equations. STCR treatments recorded higher response ratio (RR) and benefit-cost ratio (BCR) compared to blanket recommendations and farmers' practice, while STCR-IPNS treatments performed better than STCR-NPK alone. Post-harvest soil analysis for NPK indicated maintenance of soil fertility. Vijayakumar *et al*. (2017) carried out a study on STCR-based Integrated Plant Nutrition System (STCR-IPNS) using the inductive-cum-targeted yield model in non-calcareous sandy loam soils of Lithic Haplusteps at the Regional Research Station, Tamil Nadu Agricultural University, Paiyur, during *Kharif* 2013. The objective was to develop fertilizer prescription equations (FPEs) through IPNS for rice grown under the System of Rice Intensification (SRI). A ready reckoner was developed for fertilizer doses at varying soil test values to achieve grain yield targets ranging from 6 to 9 t ha^{-1}. Validation trials conducted during *Kharif* 2014 showed grain yields ranging from 2.54 t ha^{-1} in the absolute control to 8.65 t ha^{-1} in STCR-IPNS with a target of 9 t ha^{-1}. The STCR-IPNS treatment targeting 8 t ha^{-1} was found to be the most effective and economical. Yield deviations were within ±10% (90-110%), confirming the validity of the FPEs. STCR treatments recorded higher RR and BCR compared to blanket and farmers' practice, while STCR-IPNS treatments outperformed STCR-NPK alone. Post-harvest soil analysis revealed maintenance of soil fertility. Overall, the inductive-cum-targeted yield approach provided a reliable framework for sustaining soil fertility, improving productivity and enhancing nutrient use efficiency for sustainable agriculture. Sekaran *et al*. (2019) developed STCR-based fertilizer prescription equations for pearl millet under an Integrated Plant Nutrition System (STCR-IPNS) on Periyanaickenpalayam soil series (Vertic Ustropept) of Tamil Nadu. The study aimed to validate these equations through field experimentation in the Western Zone of Tamil Nadu. Results from the validation trials confirmed the accuracy of the fertilizer prescription equations, with achieved yields falling within ±10% of the targeted values. Among the treatments, STCR-IPNS targeting 4.0 t ha^{-1} of pearl millet proved superior, recording yield increases of 59.8%, 18.7% and 89.3% over blanket recommendation, blanket plus FYM @ 12.5 t ha^{-1} and farmers' practice, respectively. The response ratio under STCR-IPNS-4.0 t ha^{-1} increased by 1.0, 0.9 and 1.5 kg kg^{-1} over blanket, blanket plus FYM and farmers' practice, respectively, while the benefit-cost ratio increased by 0.65, 0.28 and 0.79. Soil test-based fertilization improved yield, economic returns, protein content and protein yield, while maintaining or enhancing soil fertility. The magnitude of soil fertility build-up was higher under STCR-IPNS compared to STCR-NPK alone, blanket recommendations, farmers' practice and control.

Conclusion

The Soil Test Crop Response (STCR)-based fertilizer prescription approach, particularly under Integrated Plant Nutrition System (IPNS), proved effective in achieving targeted yields across different crops and soil types. STCR-IPNS consistently enhanced crop yield, nutrient uptake, economic returns and benefit-cost ratio compared to blanket and farmers' practices. The approach also ensured efficient fertilizer use while maintaining or improving post-harvest soil fertility. Overall, STCR-IPNS offers a scientifically sound and sustainable strategy for precise nutrient management and long-term soil health.

References

Agila, A., Santhi, R., Maragatham, S. and Priya, R. S. 2021. Inductive cum targeted yield model based Integrated fertilizer prescriptions for tomato (*Solanum lycopersicum* L.) under drip fertigation on an Alfisol. J. of Applied and Natural Sciences 13(3), 4065-1071.

Arya, A. and Gautam, P. 2017. Soil test crop response-based fertilizer requirement for tomato grown on Mollisol. Environment and Ecology 35(4A), 3009-3013.

Ayushi, Srivastava, A., Singh, V. K., Sen, S. and Singh, V. 2022. Soil test-based optimum integrated plant nutrient supply for attaining targeted yield of finger millet in mollisols of Northern India. Agricultural Research 11(1), 87-94.

Balamurugan, J., Santhi, R., Maragatham, S., Gopalakrishnan, M. and Dey, P. 2021. development of soil test-based fertilizer prescription equations for chrysanthemum on Alfisol. Madras Agriculture Journal 108 (1-4), 177-187.

Basavaraja, P. K., Narasimha Reddy, P. N., Rajesh, N. L. and Apoorva, K. B. 2011. Development of fertilizer prescription targeted yield-equation for carrot crop based on soil test values. Journal of Horticulture Science, 6(1), 33-36.

Basavaraja, P. K., Mohamed S. H., Dey, P. and Prakash, S. S. 2016. fertilizer prescription equations for targeted yield of rice (*Oryza sativa* L.) and their validation under aerobic condition. International Journal of Agriculture Sciences 8(4), 1003-1008.

Batabyal, K., Sarkar, D. and Mandal, B. 2015. Fertilizer-prescription equations for targeted yield in radish under integrated nutrient management system. Journal of Horticulture Sciences 10(1), 18-23.

Beena, V. I., Dey, P. and Raji Mol, R. P. 2018. Soil test-based fertilizer recommendation under integrated plant nutrition system for vegetable cowpea [Vigna unguiculata (l) walp] in Ultisols of Kerala, India. International Journal of Current Microbiology and Applied Sciences 7(1), 2420-2425.

Bhatt, P., Singh, S., Bhatt, L., Pant, P. K. and Kumar, S. 2020. Evaluation of fertilizer doses for kharif brinjal (*Solanum melongena* L.) through soil test crop response approach in Mollisols of Uttarakhand. Current Journal of Applied Science and Technology 39(19), 8-18.

Bhavya, N., Krishna Murthy, R., Govinda, K., Uday Kumar, S. N., Basavaraj, P. K., Mohamed Saqeebulla, H., Gangamrutha, G. V. and Srivastava, S. 2023. Fertilizer prescription model through soil test crop response approach for carrot (Daucus carota) on an Alfisols of Southern India. Theoretical Biology Forum 12(2), 93-100.

Coumaravel, K., Santhi, R. and Maragatham, S. 2013. Soil test crop response correlation studies under integrated plant nutrition system for hybrid maize on an Alfisol. Madras Agriculture Journal 100(7-9), 660-664.

Das, K. N., Basumatary, A. and Ahmed, S. 2017. Targeted yield precision model assessment for rice-rice crop sequences in farmers' fields in humid, sub-tropical northeastern India. Journal of Soil Science and Plant Nutrition, 16 (1): 31-47.

Dhruw, D., Srivastava, L. K., Paikra, B., Jatav, G., Mishra, H., Banwasi, R. and Prakash, O. (2023) Validation of STCR based fertilizer prescription on the farmer's field. The Pharma Innovation Journal 12(7), 569-572.

Eunice, D. H., Visveswaran, S., Rani, B., Reji Rani, O. P. and Gopinath.P. P. 2023. Evaluation of STCR based targeted yield equations of amaranthus (*Amaranthus tricolor* L.) in Southern Laterite Soils (AEU-8) of Kerala. International Journal of Plant and Soil Science 35(5), 53-58.

Gayathri, A., Vadivel, A., Santhi, R., Boopathi, P. M. and Natesan, R. 2009. Soil test-based fertilizer recommendation under integrated plant nutrition system for potato (*Solanum tuberosum* L.) in hilly tracts of nilgiris district. Indian Journal Agriculture Research 43(1), 52-56.

Getahun, D., Girma, D., Feyisa, A., Lemma, A. and Dejene, L. 2020. Verification of Soil Test Crop Response Based Phosphorus Recommendation on Bread Wheat (*Triticum Aestivum* L.) in Yaya Gulele District of North Shewa Zone, Oromia. International Journal of Applied Agricultural Sciences 6 (3), 52-56.

Ghube, N. B., Kadlag, A. D. and B. M. Kamble 2017. Soil test crop response based Integrated plant nutrition system for desired yield target of preseasonal sugarcane ratoon on Inceptisols. Journal of Applied and Natural Science 9 (2), 799 - 804.

Giri, Y. Y., Ramana Reddy, D. V., Thakur, H. V., Mote, K. J. and Singh, H. 2017. Nutrient requirements of maize based on soil test crop response correlation approach. International Journal of Pure and Applied Bioscience 5(6), 408-415.

Goyal, V., Bhardwaj, K. K. and Dey, P. 2020. Validation of soil test-based fertilizer prescription models for specific yield target of wheat on an Inceptisols of Haryana. Journal of Pharmacognosy and Phytochemistry 9(4), 1914-1920.

Jadhav, A. B., Kadlag, A. D., Deshpande, A. N., Patil, V. S. and Durgude, A. G. 2013. Soil test crop respose correlatin studies for targeting yield of tomato on Entisol. Indian Journal of Horticulture 70(1), 60-64.

Jadhav, A. B., Kadlag, A. D., Patil, V. S., Bachkar, S. R. and Dale, R. M. 2009 Response of chickpea to conjoint application of inorganic fertilizers based on STCR approach and vermicompost on Inceptisol. Journal Maharashtra agriculture University 34(2), 125-127.

Jhinkwan, S., Singh, S., Pareek, N. and Gautam, P. 2021. Optimization of integrated nutrient recommendations through soil test crop response approach for forage oats (*Avena sativa* L.) in a Mollisol. Journal of the Indian Society of Soil Science 69(2), 156-161.

Jyothi, A. B., Srijaya, T., Ramana Reddy, D. V., Madhavi, A., Surendra Babu, P. and Dey, P. 2020. Soil test based targeted yield equations for Ratoon sugarcane in alluvial soils. International Journal of Chemical studies 8(5), 2556-2560.

Katharine, P. S., Santhi, R., Chellamuthu, S., Ravikumar, V., Natesan, R. and Dey, P. 2014. Optimization of fertiliser doses through inductive cum targeted yield model for transgenic cotton under drip fertigation on an Inceptisol. Madras Agriculture Journal 101(1-3), 33-39.

Kirankumar, C., Santhi, R., Maragatham, S., Meena, S. and Chandrasekhar, C. N. 2019. Validation of soil test crop response-based fertiliser prescription equations under integrated plant nutrition system for hybrid brinjal on Inceptisol of Andhra Pradesh. Madras Agriculture Journal 106(7), 517-521.

Kokate, A., Suryavanshi, V. P., Sawant, D., Gawande, R. and Waghmare, P. 2022. Response of gram (*Cicer arietinum* L.) to STCR based fertilizer application. The Pharma Innovation Journal 11(1), 1150-1152.

Luthra, N., Srivastava, A., Chobhe K. A. and Singh, V. K. 2022. Soil test crop response approach for optimizing integrated plant nutrients supply to achieve targeted yield of hybrid maize (*Zea mays* L.) in Mollisols. Annals of Plant and Soil Research 24(1), 53-58.

Madhavi, A., Chari, M. S., Srijaya, T., Surendra Babu, P. and Dey, P. 2020. Soil test-based fertilizer prescriptions through inductive cum targeted yield model for sesamum on Alfisol. Journal of Agricultural Science and Technology 10, 115-122.

Mahajan, G. R., Pandey, R. N., Datta, S. C., Kumar, D., Sahoo, R. N. and Parsad, R. 2013. Soil test-based fertilizer recommendation of nitrogen, phosphorus and sulphur in wheat (*Triticum aestivum* L.) in an alluvial soil. International Journal of Agriculture, Environment & Biotechnology 6(2), 271-281.

Margal, P. B., Thakare R. S., Kamble B. M., Kshirsagar D. B., Patil M. R., Titirmare, N. S. and Gaikwad A. S. 2024. Effect of Soil Test Crop Response Approach on Growth and Yield of Rabi Onion in Inceptisols. International Journal of Plant & Soil Science 36 (7), 746-60. https://doi.org/10.9734/ijpss/2024/v36i74788.

Patel, A. K., Patel, K. C. and Sajid, M. 2020. Verification trial of soil test-based fertilizer prescription model for wheat in anand district of gujarat. International Journal of Current Microbiology and Applied Sciences 9(11), 3818-3827.

Patil, V. S., Margal, P. B., Patil, K. B., Thakare, R. S., Todmal, S. M. and Kamble B. M. 2026. Fertiliser Prescription for Rabi Onion by Soil Test Crop Response Approach with Vermicompost and Bio-fertiliser in Inceptisols. Indian Journal of Fertilisers 22 (2), 12-19

Raghuveer, Baghel, S. S., Puri, G., Aher, S. B. and Jatav, R. C. 2017. Targeted yield concept-based fertilizer recommendation for garlic (Allium sativum L.) in black soil of Madhya Pradesh. International Journal Pure Applied Bioscience 5(3), 678-689.

Rajamani, K., Madhavi, A., Srijaya, T., Babu, P. S. and Dey, P. 2020. Validation of Target Yield based Fertilizer Prescription for Rabi Castor in Alfisol. International Research Journal of Pure and Applied Chemistry 21(23), 166-173.

Ramamoorthy, B., Narasimhan, R. L., Dinesh, R. S. 1967. Fertilizer application for specific yield targets of Sonara-64. Indian Farming. 17(5), 43-45.

Rawat, S., Singh, S., Gangola, P. and Gautam, P. 2015. Studies on soil test crop response correlation for optimizing fertilizer recommendation to okra grown on Mollisol of Uttarakhand. International Journal of Basic and Applied Agricultural Research 13(2), 254-257.

Reddy, K. J., Chandrashekara, C. P., Biradar, D. P., Rajakumar, G. R. and Kanannavar, P. S. 2022. Effect of soil test crop response (STCR) and STCR -integrated plant nutrition system (IPNS) based fertilizer prescription equations on maize productivity, economics and soil fertility status in Vertisols of Northern Karnataka. International Journal of Plant and Soil Science 34(24), 1-8.

Reddy, T. P., Srijaya, T., Madhavi, A., Sahana, F., Lakshmi, D. V. and Ravindhar, K. 2022. Validation of soil test and yield target-based fertilizer prescription equation for sugarcane on Vertisols of Northern Telangana Zone. Biological Forum - An International Journal 14(4a), 385-389.

Sakarvadia, H. L., Polara, K. B., Vekaria, L. C., Ponkia, H. P. and Babariya, N. B. 2016 Fertilizer recommendation based on soil testing for the targeted yield of pegeonpea in vertisols. The Bioscan 11(4), 2339-2342.

Santhi, R., Natesan, R. and Selvakumari, G. 2002, Soil test-based fertilizer recommendation under IPNS for aggregatum onion in Inceptisols of Tamil Nadu. Agropedology 12, 141-147.

Sekaran, U., Santhi, R., Dey, P., Meena, S. and Maragatham, S. 2019 Validation of soil test and yield target based fertilizer prescription model developed for pearl millet on Inceptisol. Research on Crops 20(2), 266-274.

Sellamuthu, K. M., Santhi, R., Maragatham, S. and Dey, P. 2019. Balanced fertilizer prescription for big onion through inductive cum targeted yield model on an Alfisol. Madras Agriculture Journal 106(10), 627-632.

Sharma, G. K., Mishra, V. N., Maruti Sankar, G. R., Patil, S. K., Srivastava, L. K., Thakur, D. S. and Rao, C. 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, 2177-2190.

Singh, J., Mavi, M. S. and Saini, S. 2022. Fertilizer prescription for target yield of wheat (Triticum aestivum) in alluvial soils. Indian Journal of Agricultural Sciences, 92(12), 1502-1505.

Singh, M., Singh, Y. V., Singh, S. K., Dey, P., Jat, L. K. and Ram, R. L. 2017. Validation of soil test and yield target based fertilizer prescription model for rice on Inceptisol of Eastern Zone of Uttar Pradesh, India. International Journal of Current Microbiology and Applied Sciences 6(2), 406-415.

Singh, S. P., Paikra, K. K. and Patel, C. R. 2020. Soil test crop response based fertilizer prescriptions under integrated plant nutrient supply for targeted yield of potato (Solanum tuberosum L) in Inceptisols. Journal of Pharmacognosy and Phytochemistry 9(1), 1902-1906.

Singh, V. K., Gautam, P., Nanda, G., Dhaliwal, S. S., Pramanick, B., Meena, S. S., Walaa F. A., Gaber, A., Sayed, S. and Hossain A. 2021. Soil Test Based Fertilizer Application Improves Productivity, Profitability and Nutrient Use Efficiency of Rice (*Oryza sativa* L.) under Direct Seeded Condition. Agronomy 11,1756.

Singh, Y. V., Singh, S. K., Meena, R. N. and Jatav, H. S. 2020. Soil test crop response approach for optimizing integrated plant nutrient management supply for coriander in an Inceptisol of Eastern Uttar Pradesh. Journal of the Indian Society of Soil Science 68(1), 114-119.

Singh, Y. V., Singh, S. K., & Dey, P. 2018. Fertilizer requirement of lentil based on soil test crop response correlation approach in an Inceptisol. Journal of the Indian Society of Soil Science 66(3), 324-328.

Sreelatha, T., Ramana Reddy, D. V. and Ramalakshmi, C. H. S. 2021. Soil test based fertilizer prescriptions for specific targeted yield of sugarcane (Ratoon) in clay loam soils (Inceptisols) of north coastal Andhra Pradesh, India. International Journal of Chemical Studies 9(1), 3462-3468.

Sugumari, M. P., Maragatham, S., Santhi, R. and Priya, R. S. 2021. Development of soil test crop response based fertilizer prescriptions through integrated plant nutrition system for aggregatum onion (*Allium cepa* L.) under drip fertigation. Journal of Applied and Natural sciences 13(3), 1094-1101.

Suresh, R. and Santhi, R. 2019. Inductive Approach as a Basis for Fertilizer Prescription through Integrated Plant Nutrition System for Maize on Vertisol. Madras Agricultural Journal 106(4-6), 316-324.

Tripathi, V., Srivastava, A., Gangwar, S. P. and Singh, R. K. 2018. Soil test crop response based fertilizer prescription for urd grown on Mollisol of Uttarakhand, India. International Journal of Current Microbiology and Applied Sciences 7(7), 90-101.

Tripathi, V., Srivastava, A. and Singh, M. 2020. Fertilizer prescription based on soil test crop response approach in marigold-urd cropping system grown in soils of Uttarakhand. Progressive Agriculture 20 (1 and 2), 80-92.

Truog, E. 1960. Fifty years of soil testing, Proc. Trans 7^{th} Intl. Congr. Soil Sci. Vol. III Commission IV paper No.7, 46-53.

Udayakumar, S. and Santhi, R. 2017 Soil test based integrated plant nutrition system for pearl millet on an Inceptisol. Research on Crops 18 (1), 21-28.

Upadhyay, S. P., Gautam, P. and Mishra, G. 2017. Soil Test Crop Response Based Fertilizer Requirement for Barley. Environment and Ecology 35(2D), 1443-1446.

Vijayakumar, M., Santhi, R. and Jalaluddin, S. M. 2017. Refinement of fertilizer recommendation based on Soil Test Crop Response technology for rice under System of Rice Intensification. Journal of Applied and Natural Science 9(2), 855 -859.

Yadav, S. R., Meena, B. S., Choudhari, A., & Kumar, S. 2021. Targeted Yield based Integrated Nutrient Management of Cabbage in Torripsamment. Annals of Arid Zone 60(3 and 4), 75-78.