

**SUITABILITY OF FERTILIZER RECOMMENDATION
EQUATION DERIVED FOR WHEAT CROP IN A
VERTISOL OF FARMER'S FIELD**

M. Sc. (Ag.) Thesis

by

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**DEPARTMENT OF SOIL SCIENCE AND
AGRICULTURAL CHEMISTRY
COLLEGE OF AGRICULTURE
INDIRA GANDHI KRISHI VISHWAVIDYALAYA,
RAIPUR (Chhattisgarh)**

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Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

Soma Banchhor

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF**

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in
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CERTIFICATE – I

This is to certify that the thesis entitled “ **Suitability of fertilizer recommendation equation derived for wheat crop in a *Vertisol* of farmer’s field.**” submitted in partial fulfillment of the requirements for the degree of “**Master of Science in Agriculture**” of the Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) is a record of the bonafide research work carried out by **Soma Banchhor** under our guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or has been published/ published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by her.

Date:

21/10/21

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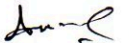
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Saxena

CERTIFICATE – II

This is to certify that the thesis entitled “**Suitability of fertilizer recommendation equation derived for wheat crop in a Vertisol of farmer’s field.**” submitted by **Ms. Soma Banchhor** to the **Indira Gandhi Krishi Vishwavidyalaya, Raipur**, in partial fulfillment of the requirements for the degree of **Master of science in agriculture** in the **Department of Soil Science and Agricultural Chemistry** has been approved by the external examiner and Student’s Advisory Committee after an oral examination, **under the chairmanship of Head of the Department.**


Signature of Head of the Department
(Name: Dr. ANURAG).

Date:- 11-11-2021

Major Advisor



Faculty Dean

Approved/Not approved

Director of Instructions

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Research is all about creating some new knowledge, it needs much patience, co-operation of the friends, colleagues and guidance of experts with add on vigor and dedication of the person .”Education plays vital role in personal and social development and teacher plays a fundamental role in impacting education and knowledge among students.

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Soma Banchhor

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LIST OF ABBREVIATIONS

Abbreviations	Descriptions
%	Percent
dS m ⁻¹	Deci Simens per meter
et al	Et alii (and other)
Fig	Figure
FYM	Farm Yard Manure
g	Gram
gm ha ⁻¹	Gram per hectare
GM	Green manure
ha	Hectare
i.e.,	id est (that is)
Kg	Kilogram
Kg ha ⁻¹	Kilogram per hectare
Mg m ⁻³	Mega gram per meter cube
Mg	Milligram
Mg kg ⁻¹	Milligram per kilogram
°C	Degree Celcius

THESIS ABSTRACT

- a) Title of the Thesis: Suitability of fertilizer recommendation equation derived for wheat crop in a *Vertisol* of farmer's field
- b) Full Name of the Student: Soma Banchhor
- c) Major Subject: Soil Science and Agricultural Chemistry
- d) Name and Address of the Major Advisor: Dr. V.N. Mishra, professor
Department of Soil Science and Agricultural Chemistry, College of Agriculture, IGKV, Raipur (C.G.)
- e) Degree to be awarded: Master of Science in Agriculture


Signature of Student


Signature of Major Advisor:

Date: 21/10/21


Signature of Head of Department

ABSTRACT

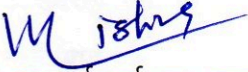
The present experiment entitled “Suitability of fertilizer recommendation equation derived for wheat crop in a *Vertisol* of farmer’s field” was conducted at village Selud, block Patan, district – Durg of Chhattisgarh state during Rabi season, 2020. The objectives of the study were to test the validity of fertilizer recommendation equations derived for wheat crop in *Vertisol* and to estimate the nutrient requirement and efficiencies of soil, fertilizer and FYM. The experiment was consisted with 8 treatments replicated four times in a randomized block design. Treatments were T₁- Control (N₀P₀K₀), T₂- FYM @ 5t/ha, T₃- (N₁₂₀P₆₀K₄₀), T₄- (N₀P₆₀K₄₀), T₅- (N₁₂₀P₀K₄₀), T₆- (N₁₂₀P₆₀K₀), T₇- (Fertilizer dose for yield target of 25q/ha (81:32:21 kg/ha NPK), T₈- Fertilizer dose for yield target of 35q/ha (139:57:50 kg/ha NPK). GW-366 variety of wheat was taken as test crop.

The application of soil test based fertilizer N, P and K yielded less than the targeted crop yield however, the yields achieved were within the limitation of $\pm 10\%$ variation. Application of soil test based fertilizer dose to achieve a yield target of 35 q/ha produced significantly highest yield followed by blanket recommendation of NPK @ 120:60:40 kg/ha and was at par with that of same dose of N and P application without K. This indicated no crop response to K application due to well supply of K by the *Vertisol* under study. Grain yield was significantly higher by the application of FYM over control and was at par with T₄ treatment that received only P and K. This shows the importance of N nutrition with which yield could be tremendously increased by two and half folds if N is included with P and K application (T₃) in a balanced manner. Nutrient requirement as kg per quintal of grain production, efficacy of fertilizer, soil and organic nutrients were assessed using the data on nutrients uptake from different sources like fertilizer, soil and FYM and yield levels. The amount of nutrients absorbed by the crop decides a definite amount of biomass production. The Quantity of nutrient needed for production of one quintal of wheat grain yield was found to be 1.92 kg N, 0.47 kg P and 2.04 kg K.

The efficacy of fertilizer, soil and FYM nutrients were estimated. The fertilizer capabilities of N, P and K for wheat crop were estimated as 31.10, 15.40 and 140.2 per cent, respectively. Similarly, the efficiencies of soil nutrients for wheat were recorded as 8.20 % N, 28.5% P and 3.30% K. The capabilities of nutrients from organic source (Farm yard Manure) were observed as 31.4% N, 14.13% P and 15.61% K for wheat crop under testing. FYM used under study was analyzed for total N, P and K content as shown in Table 4.1.5. The nutrient contents were recorded 0.45 % N, 0.35% P and 0.87 % K. The results clearly indicate that soil test based fertilizer application provides a balanced fertilization based on the crop nutrients requirement, and efficiencies of different nutrients sources. Hence, yield target based fertilizer application for a definite yield targets have recorded higher efficiencies particularly for applied N and P in comparison to that of recommended dose of fertilizer.

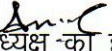
शोध सारांश

- (अ) शोध का शीर्षक : किसान के खेत में कन्हार मृदा में गेहूं की फसल के लिए प्राप्त उर्वरक सिफारिश समीकरण की उपयुक्तता।
- (ब) विद्यार्थी का पूरा नाम : कु. सोमा बंधोर
- (स) मुख्य विषय : मृदा विज्ञान और कृषि रसायन विज्ञान
- (द) प्रमुख परामर्श का नाम और पता : डॉ. वी.एन. मिश्रा
प्राध्यापक, मृदा विज्ञान और कृषि
रसायन विज्ञान कृषि महाविद्यालय
रायपुर, इं.गां.कृ.वि. (छ.ग.)
- (ड) उपाधि का नाम : स्नान्तकोत्तर (कृषि) मृदा विज्ञान एवं
कृषि रसायन


मुख्य परामर्शकर्ता का हस्ताक्षर

दिनांक 21/10/21


विद्यार्थी का हस्ताक्षर


विभागाध्यक्ष का हस्ताक्षर

सारांश

वर्तमान प्रयोग “किसान के खेत में कन्हार में गेहूं की फसल के लिए प्राप्त उर्वरक सिफारिश समीकरण की उपयुक्तता” शीर्षक से रबी मौसम, वर्ष 2020 के दौरान छ.ग. राज्य के ब्लॉक पाटन, जिला दुर्ग गांव सेलुद में आयोजित किया गया था। अध्ययन का उद्देश्य वैधता परीक्षण करना था। कन्हार मृदा में गेहूं की फसल के लिए प्राप्त उर्वरक सिफारिश समीकरणों के और पोषक तत्वों की आवश्यकता और मिट्टी उर्वरक और गोबर खाद (एक लाई हम) की क्षमता का अनुमान लगाना था प्रयोग में 8 उपचार शामिल हैं। उपचार 1 नियंत्रित (NOPOKO), उपचार 2 गोबर खाद @5टन/है., उपचार 3 [N120P60K40], उपचार 4 (NOPCOK40), उपचार 5 [N120P0K40], उपचार 6 [N120P60K0], उपचार 7 (25 क्व./है.) उपज लक्ष्य के लिए उर्वरक मात्रा (81:32:21 कि.ग्राम/है. NPK), उपचार 8, 35 क्व./है. (139:57:50 कि.ग्र./है. NPK), गेहूं की GW-366 किस्म को परीक्षण फसल के रूप में लिया गया।

प्रयोग में मृदा परीक्षण आधारित उर्वरक नत्रजन, फास्फोरस एवं पोटैश उर्वरकों के उपचार में लक्षित उपज से कम उपज प्राप्त हुई। हालांकि प्राप्त उपज ± 10 प्रतिशत भिन्नता की सीमा के भीतर थी। 35 क्व./है. के उपज लक्ष्य को प्राप्त करने के लिए मृदा परीक्षण आधारित उर्वरक की मात्रा का प्रयोग करने पर उल्लेखनीय रूप से उच्चतम उपज प्राप्त हुई तथा इसके बाद उपचार 3 में (NPK@120:60:40 कि.ग्र./है.) यह दोनो उपचार (उपचार 8 और उपचार 3) उपचार 6 के बराबर थे जहां नत्रजन एवं फास्फोरस उर्वरक की समान मात्रा आयोग की गई थी तथा पोटैश की मात्रा का उपयोग नहीं किया गया था (N20PEOKO), यह बतलाना है कि फसल पर पोटैश के उपयोग का कोई प्रभाव नहीं पड़ा क्योंकि कन्हार मृदा से पौधों को पर्याप्त मात्रा में पोटैश तत्व की प्राप्ति हो गई थी।

प्रयोग में गोबर खाद (एफ वाई एम) के उपयोग से अनाज की उपज नियंत्रित उपचार की तुलना में अधिक प्राप्त हुई उपचार-2, यह उपज उपचार-4, के बराबर थी, जिसमें की फास्फोरस और पोटैश दिया गया था। उपचार-4 का उपज नत्रजन के महत्व को दर्शाता है क्योंकि फास्फोरस और पोटैश के साथ नत्रजन संतुलित तरीके से शामिल करने पर उपज में ढाई गुना वृद्धि हो सकती है। प्रति क्विंटल अनाज उत्पादन के लिए पोषक तत्वों की आवश्यकता उर्वरक की प्रभावकारिता मिट्टी और जैविक पोषक तत्वों का आकलन विभिन्न स्रोतों जैसे उर्वरक मिट्टी और एफ वाई एम और उपज स्तर से पोषक तत्वों के आकड़ों का उपयोग करके किया गया था।

फसल द्वारा आयोजित पोषक तत्वों की मात्रा पौधों के कुल उपज उत्पादन की एक निश्चित मात्रा तय करती हैं। एक क्विन्टल गेहूं की उपज के दौरान उत्पादन के लिए आवश्यक पोषक तत्वों की मात्रा 1.92 किग्रा नत्रजन, 0.47 किग्रा. फास्फोरस और 2.04 किग्रा पोटैश पाई गई।

उर्वरक मिट्टी और एफ वाई एम पोषक तत्वों की प्रभावकारिता का अनुमान लगाया गया था। गेहूं की फसल के लिए नत्रजन, फास्फोरस और पोटैश की उर्वरक क्षमता क्रमशः 31.10, 15.40 और 140.2 प्रतिशत अनुमानित की गई थी। इसी तरह गेहूं के लिए मिट्टी के पोषक तत्वों की क्षमता 8.20 प्रतिशत नत्रजन, 28.5 प्रतिशत फास्फोरस और 3.30 प्रतिशत पोटैश दर्ज की गई। जैविक स्रोत (फार्म यार्ड खाद) से पोषक तत्वों की क्षमता 31.4 प्रतिशत नत्रजन, 14.13 प्रतिशत फास्फोरस और 15.61 प्रतिशत पोटैश के रूप में देखी गई। प्रयोग में परीक्षण के तहत गेहूं की फसल के लिए अध्ययन के तहत प्रयुक्त एफवाईएम का विश्लेषण कुल नत्रजन, फास्फोरस और पोटैश सामग्री के लिए किया गया था जैसा कि तालिका 4.1.5 में दिखाया गया है पोषक तत्वों की मात्रा 0.45 प्रतिशत नत्रजन, 0.35 प्रतिशत फास्फोरस और 0.87 प्रतिशत पोटैश दर्ज की गई। परिणाम स्पष्ट रूप से इंगित करते हैं कि मिट्टी परीक्षण आधारित उर्वरक आवेदन फसल पोषक तत्वों की आवश्यकता और विभिन्न पोषक स्रोतों की क्षमता के आधार पर एक संतुलित उर्वरक प्रदान करता है। इसलिए एक निश्चित उपज लक्ष्य के लिए उपज लक्ष्य आधारित उर्वरक आवेदन से उर्वरक की अनुशंसित खुराक की तुलना में विशेष रूप से नत्रजन और फास्फोरस तत्व के लिए उच्च दक्षता दर्ज की है।

CHAPTER-I

INTRODUCTION

A recent estimation released by the Govt. of India, Ministry of Agriculture and Farmers Welfare in forth advance estimates of production of major agricultural crops, a record of 308.65 million tones of food grain have been produced during 2020-21. The population of our country is estimated to touch about 1.4 billion by the year 2025 and to feed this population; we may need 325MT food grains which may become a challenging task to achieve by 2025 without improvement in soil health. On the other hand, shrinking of agricultural land, limited agricultural inputs, vagaries of weather etc. may not support for continuous increasing food grain production. Therefore it is important that soil testing technique through balanced fertilization with integrated nutrient combine protect soil health. The management of plant nutrients in agriculture through manures and fertilizers is one of the most important scientific technical works. Crop balanced fertilization make sure better quality of produce, conservation of our precious soil and water resources and maintenance of soil fertility. Balance nutrition make sure that available form of nutrient in proper quantity and required proportion in the soil meet essential requirement of crops for acquiring desirable level of yield. It is rarely found that nutrient present in the soil with appropriate amount. Some nutrients like potassium and micronutrients like Fe Zn, Cu Mn may be present in more than sufficient to meet the crop nutrients requirement whereas, soil N and P may not be present in sufficient and these imbalances need to correct in a balanced manner by external application based on the crop nutrients requirement and estimated nutrients efficiencies from soil, fertilizers and organic manures. Therefore, it wants more comprehensive approach for fertilizer use, incorporating components like soil test, field research and economic evaluation of the results.

Introduction of high yielding fertilizer responsive varieties of any crop with expansion of assured irrigation can only contribute to higher food grain production .Simultaneously, impact of imbalanced and indiscriminate use of chemical fertilizer has negative effect on soil fertility and productivity. Decline in soil

fertility is more alarming in intensively cultivated region where in nutrient uptakes by crops are high and replenishment is not only inadequate but also imbalanced in favour of Nitrogen. Status of soil fertility reduce fast and long period, it may influence sustainability and productivity. Therefore, it is essential to protect the soil health by using judicious and balanced fertilization through soil testing.

Balanced fertilization of crops ensures improved quality of produce, maintenance of soil fertility and conservation of our precious soil and water resources. Balance nutrition does not mean the application of nitrogen, phosphorus and potassium alone in certain proportion through fertilizer, but it should ensure that the nutrient in available forms is in adequate quantity and in required proportion in the soil to meet the requirement of the crops for obtaining the desired levels of yield. Nutrient available in the soil are rarely present in adequate amounts and in balanced proportion to meet the requirement of the crops. This requires intervention by application of external sources of nutrients i.e., fertilizers and manures. Soil test provides the requisite information about amounts of the nutrients available in soil and their imbalances, while fertilizer recommendations aim to correcting the imbalances in nutrient to crop requirement.

Based on quantitative or semi quantitative approaches recommendation dose of fertilizer do not give expected yield response. Therefore, it need better comprehensive approaches for fertilizer use, incorporating components like soil test, field research and economic evaluation of the results. One of the high cost input in agriculture is fertilizer and use of correct amount of fertilizer is fundamental for farm desirability and environmental protection. To enhance farm profitability under different soil-climate conditions, it is necessary to have information on optimum doses for the crops. Traditionally, fertilizers are generally applied to crops on the basis of generalized state level fertilizer recommendations. However, the fertilizer requirement of a crop is not a static one and it may vary for the same crop from soil to soil and even from field to field on the same soil. Soil testing as a diagnostic tool, the value of soil testing both in general and specific terms is to identify soil fertility problems and constraints in an area and to give specific fertilizer recommendation based on soil analysis of a farm holding.

Soil test crop response (STCR) studies help to generate fertilizer adjustment equations and calibration charts for recommending fertilizers on the basis of soil tests and achieving targeted yield of crops (Singh and Biswas, 2000). In India, Ramamoorthy *et al.* (1967) established the theoretical basis and experimental proof for the fact that Liebig's law of minimum operates equally well for N, P and K. This forms the basis of fertilizer application for targeted yields. Fertilizer recommendation based on yields targeting is unique in the sense that this method not only indicate soil test-based fertilizer dose but also the level of yield that farmer can hope to achieve if good agronomic practices are followed in raising the crop. One of the important advantages of this approach is that farmers have the options to relate their resources with a desired level of yield target. Choosing the appropriate target and application of required amount of plant nutrient ensure the most judicious and balanced fertilization and also helps to sustain soil productivity and crop production. Targeted yield concept thus, strikes a balance between fertilizing the crop and fertilizing the soil. The formulation of soil test-based fertilizer equations generated for a particular soil type and climatic conditions requires validation for their suitability in similar soil and climatic conditions.

Under All India Coordinated Research Project on Soil Test-Crop Response at Raipur center have generated many useful information on soil test-based fertilizer application for different crops under various soil condition. This information is needed to test their suitability for similar soil situation on farmer's fields with different varieties of the same crop.

As wheat is an important cereal crop after rice, hence, keeping the aforesaid points into consideration, the present study on “**Suitability of fertilizer recommendation equation derived for wheat crop in a *Vertisol* of farmer's field**” was carried out with following objectives

- To test the validity of fertilizer recommendation equations derived for wheat crop in *Vertisol*.
- To estimate the nutrient requirement and efficiencies of soil, fertilizer and FYM.

CHAPTER-II

REVIEW AND LITERATURE

In this chapter, a review of literature pertaining to study on “Suitability of fertilizer recommendation equation derived for wheat crop in a *Vertisol* of farmer’s field” at village Selud, block Patan, district – Durg of Chhattisgarh state during Rabi season, 2020” carried out by various researchers in Chhattisgarh, India and abroad has been briefly mentioned. The literatures on the aspect have been reviewed as per the objectives of the study.

Only a scientifically sound fertiliser programme can be created to promote balanced nutrition of any crop and efficient nutrient usage of available natural resources. Nutrient addition in the form of fertiliser is necessary when the supply of nutrients becomes insufficient for normal plant growth. The amount of plant nutrients added is influenced by knowledge of the soil’s nutrient supplying power and fertiliser efficiency. A soil test is simply a relative, not an absolute, indicator of the amount of plant nutrients available to the root system. It only has significance when it is linked to plant performance.

The classification of soils into classes for the purposes of fertiliser and lime requirements, the prediction of the probability of obtaining a profitable response to the applied fertiliser nutrients, and the determination of specific conditions that may be improved by cultural practises are all important objectives of soil testing (Fits and Nelson, 1956). Tisdale (1967) said it well when he said, Soil testing is to the art of crop production what the thermometer is to the medical profession . A soil test extracts and evaluates the key ingredients for plant nutrition chemically. It also uses pH to determine if the soil is acidic or alkaline. These variables indicate the amount of lime required, the availability of nutrients, and the soil's ability to grow crops (Tucker and Carter, 1998).As a result, Kanwar (1971) referred to soil testing as the principal weapon in a soil scientist's armoury.

A soil test value has no actual importance unless it is linked to crop response and properly interpreted in relation to a fertiliser recommendation. The

soil test, according to Kanwar (1971), is a gimmick unless it accurately assesses fertility state and estimates fertiliser requirements for maximum return or a specific yield goal. According to Melsted and Peck (1973), soil testing findings reveal nothing about the soil's ability to produce or the amount of fertiliser that must be applied to attain a desired yield. Correlating data acquired from soil sample analysis with known field response is how test findings are interpreted. The precision with which a crop responds to various soil nutrient levels. Several scientists have used the terms calibration and correlation interchangeably, but Welch and Wiese (1973) coined the term correlation to describe the link between soil test findings and yield responses observed as the amount of nutrients supplied increased. Cope and Rouse (1973) described calibration as the process of determining the relationship between soil test value and crop yield. Following soil sample, extracting the amount of nutrient available and selecting a proper extract that is modified to fit the individual soil condition is the next critical step.

The essential idea of soil testing is that it is based on a sample-based analytical technique that may be devised to precisely assess available nutrients. With this in mind, Bray (1948) proposed that the requirement for successful soil testing be extracting the total or proportionate part of the available from or forms of a nutrient from soil with variable properties, and the procedure used should extract the total or proportionate part of the available from or forms of a nutrient from soil with variable properties.

The amount of nutrients in the extract should be assessed with reasonable precision and speed, and the amount of extract should be connected with each crop's growth and responsiveness to that nutrient under different conditions. In terms of fertiliser suggestion, Chand (1993) noted that the success of soil testing is dependent on the right stage of sample preparation, extraction, calibration, and interpretation of the test results.

The productivity of any crop depends upon various factor viz, climate conditions soil properties, seed quality and variety, irrigation facilities, insects-pest and disease management etc. but most important is the optimum and balanced

use of inorganic fertilizer nutrients especially macro and micro nutrient. It is very essential to encourage the application of minerals nutrient at optimum dose for sustainable management and maintaining soil health. To get maximum benefit and reduce losses from the fertilizers, it must be applied in right quantity, sources at combination at right time and right manner. Application of balanced dose of chemical fertilizers is very crucial for getting maximum yield but application of organic manures before sowing along with the fertilizer gives good result by maintaining sustainability of soil for longer period of time. Thus, it is very difficult to recommend a general schedule of fertilizer application without initial soil test value, depending on the initial status of nutrients in the soil and getting desired level of targets as per the potential of varieties, chemical fertilizers which are costly and energy consuming to be applied judiciously.

Soil test crop response correlation study (STCR) is a base for prescription of right amount of fertilizers to the crops. No single dose of plant nutrient applied through inorganic fertilizer, organic manure, crop residue or bio- fertilizers can meet the entire nutrient requirement of a crop in modern intensive agriculture (Gangwaret *al.*, 2016; Udaya kumar and Santhi, 2017). STCR approach provides the balanced supply of required quantities of nutrients to the crops thus avoiding the over and under usage of fertilizers. This prevents the environmental hazards and results in higher returns.

Fits Some of the more important objectives of soil testing, according to and Nelson (1956), include grouping soils into classes for the purpose of determining fertiliser and lime requirements, predicting the probability of getting a profitable response to fertiliser nutrients application, and determining specific conditions that may be improved by cultural practices .In light of all of this, Kanwar (1971) suggests, “Soil Testing as the key weapon in the armory of a soil scientist”.

The validity of Ramamoorthy *et al.* (1967)'s fertiliser adjustment equation was examined, and the results showed that in most of the cases tested, yield targets may be met with a 10% variance. According to Meelu (1979), yield targets of up to

40 quintals per hectare could be achieved with fair certainty, but yield deviated considerably for larger targets, limiting the concept's application. Similar observation was also made by (Shekhon *et al.* (1990); Verma and Singh (1990); Chand (1993); Dhillon (1995); Velayuthan (1979) revealed that this approach provided scientific basis for balanced fertilization. The result of various center's have been summarized by Velayutham *et al.* (1985) describing the origin, philosophy and objectives of soil test crop response correlation studies.

Tamboli *et al.* (1996) reported that the 2.92 kg N, 1.43kg P₂O₅ and 0.72 kg K₂O from soil and fertilizer were 26,55, 3 and 70.3, 28.9, 23.1%, respectively. Supported results, equations for fertilizer recommendation were projected and tested for their validity by large numbers of follow-up trails conducted at different locations on farmer's field. The results of such 31 trials showed that returns were highest whenever appropriate fertilizer rate was applied after soil test compared with applying general recommended fertilizer rate.

On the basis of basic data generated from field experiments conducted in Samana sandy loam and Gulpur loam soils at the Punjab Agriculture University farms in Ludhiyana and Gurudaspur,

Dhillon *et al.* (1997) developed fertiliser prescriptions models for wheat, rice, pearl millet, mustard, and green gram. The validity of these fertiliser adjustment equations was tested over an eight-year period on farmer's fields by conducting yield target trials with these crops. The results show that when fertiliser was applied on a soil test basis (10 percent deviation from the target), wheat, rice pearl millet, mustard, and green gram yield targets were met within reasonable limits in the majority of cases, establishing the unity of the adjustment equations for recommending soil test based fertiliser to farmers. When fertilisers were applied on the basis of a targeted yield concept, greater output/ input ratios were found for diverse crops, indicating higher fertiliser usage efficiency. Jadhav *et al.* (1997) in a pot experiment on rice observed that uptake of major nutrients were highest from 75 kg N ha⁻¹ as urea + 25 kg N as vermicompost.

Prasad *et al.* (1998) reported that the average nutrient requirement for the production of one quintal of wheat grains were 2.01 kg N, 0.54 kg P₂O₅ and 2.63 kg²⁴ K₂O in *Alfisols*.

Reddy *et al.* (1999) estimated the requirement of NPK as 4.5, 0.77 and 3.58 kg, respectively to produce one quintal of dry chilli. The yield targets of 25 to 30 q ha⁻¹ were achievable at this rate of NPK application

Toor *et al.* (1999) while evaluating the effect of vermin-compost prepared from different crop residues, reported that increasing rate of vermin-compost application increased N and P uptake by wheat.

Sharma and Singh (2000) estimated the basic data as nutrient requirement of N, P₂O₅ and K₂O were 2.57, 0.82 and 2.98 kg for one quintal of grain production, respectively. The utilization efficiency of soil available N, P and K were 25.1, 53.6 and 29.0 per cent while from fertilizer nutrients it were 52.9, 28.1 and 135.6 per cent, respectively. The fertilizer adjustment equations were obtained from basic data for achieving targeted yield of wheat These equations were tested by follow up trial at IARI farm from for achieving the yield target of 42.53 q ha⁻¹ of wheat grain and fertilizer doses applied were 103 N, 53 P₂O₅ and 43K₂O kg ha⁻¹. The targeted yield treatment resulted in a yield of 44.17 q ha⁻¹, up from 42.53 q ha⁻¹, a +3.9% increase. This demonstrated that the yield may be obtained with a +10 percent variation. They came to the conclusion that fertiliser recommendations based on a targeted yield approach were more balanced, profitable, and effective in preventing soil nutrient mining, which is critical for crop sustainability.

According to Sushila and Giri (2000), applying farm yard manure to wheat boosted its growth, yield, and water usage efficiency. Wheat growth and yield were also improved by applying up to 90 kg ha⁻¹ of nitrogen. The use of FYM resulted in a 45 kg N ha⁻¹ reduction.

according to Yadav *et al.* (2000) In comparison to control plots, rice and wheat yields were consistently greater in years when a complete dose of NPK was applied through fertilisers coupled with organic manures,

The farmer's application of fertiliser nutrients without knowledge of soil fertility state and crop nutrient requirements has a negative impact on the soil and crop (Ray et al., 2000). Given the high cost of fertilisers and the negative impact of their abuse on the environment and soil health, making accurate organic manure-fertilizer recommendations based on soil test results, residual effect, and yield targets is critical. At such point of time, 'unique inductive cum targeted yield model' of Ramamoorthy *et al.*, (1967) to develop proper manure-fertilizer prescription becomes very useful (Santhi *et al.*, 2011-12)., 'Targeted yield model' is one of the practical approaches for efficient use of fertilizers. Theory of formulating optimum fertilizer recommendations for targeted yields was first given by Troug (1960) which was further modified by Ramamoorthy *et al.*, (1967). A specific amount of nutrients must be supplied to a crop in order to achieve a specific yield target, and this requirement can be determined by considering the contribution of native soil accessible nutrients as well as fertiliser nutrients applied (Subba Rao and Srivastava, 2001).Ramamoorthy *et al.*,(1967) Traditionally, the most appropriate method for determining optimum fertiliser doses has been to apply fertiliser based on test of soil results and crop response correlation studies using the targeted yield approach to develop an association in the middle of crop yields on the one hand, soil test values and fertilizer put in on the further.

Puri and Gorantiwar (2001) report that the nutrient needs to produce one quintal of wheat grain in *Vertisols* are 2.2kg N, 0.80kg P₂O₅ and 4.23kg K₂O. Fertilizer use efficiency by wheat with respect to N,P₂O₅ and K₂O was 50, 20 and 15% and for the soil efficiency was 20, 50 and 20%, respectively. Targeted yield equations for scheduling of fertilizer dose for specific yield of wheat for the year 1972-96 may be satisfactorily used within $\pm 10\%$ yield deviation for the yield target of 30, 40 50q ha⁻¹. The yard stick values for soil test based applied nutrients were higher on ones used general recommendation.

Meena *et al.* (2001) reported the nutrient requirement for producing one quintal of onion bulb in *Alfisol* as 0.26kgN, 0.22kg P₂O₅ and 0.20kg K₂O. The contribution (%) from soil and fertilizer nutrient were 21.31 and 44.37 for N, 25.38 and 27.71 for P and 5.76 and 48.57 for K, respectively. Similarly, Santhi *et al.*

(2004) also reported the basic information for sunflower yield in *Inceptisol* of Tamil Nadu. They observed that 0.375 kg P₂O₅ and 0.466kg K₂O were required to produce one quintal onion yield. Contribution of soil and fertilizer nutrients were found to be 14.13 and 38.28 per cent for N, 35.33 and 56.61 per cent for P₂O₅ and 14.33 and 70.03 per cent for K₂O, respectively.

Puri and Bhargav (2001) investigated targeted yield equations for fertiliser rate scheduling to achieve a certain rice production. From 1972 to 1996, follow-up trials were undertaken using the STCR-generated fertiliser formulae. These equations can be used to achieve a yield objective of 30, 40, or 50 q/ha within a ten per cent variance. When compared to the general recommended dose of nutrients, the yardstick value of the pre-set targets for soil test based applied nutrients was greater. The observed and targeted yields have a significant correlation ($r=0.5261^*$).

Parihar (2004) also noted that grain yields procure with 80 kg N ha⁻¹ (50% through green manure + 50% through urea) were comparable to 80 kg N ha⁻¹ (50% through FYM + 50% through urea), but both were significantly superior over 80 kg N through urea. Integrated sources of nutrients (organic + inorganic) had residual effect on succeeding wheat yield and nutrient uptake of rice wheat system.

Verma *et al.* (2005) conducted forty-one field verification trials in maize, rice, and wheat in farmer's fields in Himachal Pradesh, India, between 1995 and 2001 to determine the validity of soil test-based fertiliser prescriptions for meeting particular yield targets. For differing levels of desired yields of maize, rice, and wheat, different fertiliser recommendation methods, as well as fertiliser doses derived by fertiliser adjustment equations, were assessed. Up to yield targets of 5 tone ha⁻¹ for rice and maize, and 4 tone ha⁻¹ for wheat, fertiliser recommendations based on the targeted yield concept were found to be more exact and dependable.

Among the various methods of fertiliser recommendation, such as general recommended dose (GRD), soil test based recommendation, and so on, soil

test crop response (STCR) is unique in that it indicates that good agronomic practises can achieve both soil test based fertiliser dose and yield level (Singh et al. 2005).

Suri *et al.* (2005) conducted an experiment in the wet temperature zone of Himachal Pradesh to determine the N, P, and K requirements per quintal of crop grain production, the efficiency of soil accessible nutrients, and the efficiency of applied nutrients in soybean.

The results revealed that one quintal of soybean seed required 6.48, 3.99, and 1.12 N, P₂O₅, and K₂O, respectively.

For soybean, the soil contribution of P₂O₅ was 16.1%, while fertiliser contributed 56 percent. The response to phosphatic fertilizer was high resulting in higher phosphate use efficiency, per cent contribution of K₂O from soil was 10.8 for soybean while that from fertilizer was 35.0%.

Vardana *et al.* (2008) found that applying organic manures (FYM and vermin-compost) to pearl-millet crops increased NPK uptake. Vidyadharan (2008), working on barley at Jobner, found that applying vermicompost at 6 t/ha increased N, P, and K content in grain and straw, protein content in grain, and NPK uptake significantly over control.

When compared to other treatments, Channabasana *et al.* (2008) found that applying vermicompost @ 3.8 t ha⁻¹ and poultry manure @ 2.4 t ha⁻¹ resulted in significantly higher plant height (86.30 cm) and number of tillers (94.60) per square meter at 90 DAS, as well as significantly higher test weight (42.73 g), seed yield (3043 kg ha⁻¹), and protein content (13.41%) in wheat crops.

Rajput (2008) studied the effect of nutrient management practices on the growth and yield of pearl millet (Pusa 605). With 5 tones of farmyard manure per acre, the highest yield was achieved. With each unit increase in N level (0, 30, and 60 kg/ ha), pearl millet growth, yield components (Plant population, plant height, and test weight), and yield improved. With the highest N level, the highest grain yield (24 q/ha) was obtained.

According to Prasad et al. (2010), the grain production of maize and wheat cropping systems rose dramatically as NPK levels increased. Under 50 percent N through FYM + 50 percent N through inorganic fertiliser in Kharif and 100 percent RDF in Rabi, the greatest yields of maize (4.40 t ha⁻¹), wheat (3.62 t ha⁻¹), and the system (8.92 t ha⁻¹ in terms of maize equivalent) were reported.. Over 100 percent RDF applied in both the kharif and Rabi seasons, maize yield increased by 0.54 t ha⁻¹, wheat yield increased by 0.32 t ha⁻¹, and maize equivalent yield increased by 0.93 t ha⁻¹. The application of 50 percent nitrogen through FYM and 50 percent nitrogen through chemical fertiliser to both crops is comparable to 25 percent nitrogen substitution through FYM and 75 percent nitrogen substitution through inorganic sources. Maximum production increase over control was recorded in 50 percent N FYM+50 percent RDF, followed by 25 percent N FYM +75 percent RDF, and minimum in case of farmers practice (50kg urea ha⁻¹).

Apoorva *et al.* (2010) reported that the effective fertilizer recommendation should consider crop needs and nutrient already available in the soil. Among the various methods of fertiliser recommendation, including the general recommended dose (GRD), soil test-based recommendation, critical value approach, and others, the soil test crop response (STCR) approach for targeted yield was unique in that it indicated both the soil test-based fertiliser dose and the level of yield that can be achieved with good agronomic practice.

Brajendra *et al.* (2012) reported that the nutrient requirement (kg q⁻¹) of N, P₂O₅ and K₂O were found to be 6.97, 1.42 and 1.04, respectively for producing one quintal of maize yield in Meghalaya. Similarly, 4.06, 1.60 and 2.15 kg q⁻¹ N, P₂O₅ and K₂O were required for producing one quintal of rice yield in Meghalaya.

Singh *et al.*, (2015) developed fertilizer prescription equations for maize by conducting a field experiment on *Inceptisol* of Agricultural Research Farm, Banaras Hindu University, Varanasi (UP) during kharif season, 2012 using IPNS approach on the basis of STCR concept. The nutrients required to produce one tone (1 t) of maize grain (NR), contribution of nutrients from fertilisers (percent CF), contribution of nutrients from soil (percent CS), and contribution of nutrients from

organic matter (percent CS) were calculated using soil test data, maize grain yield, and NPK uptake by maize crop (percent CFYM).

It was discovered that 1 t maize grain required 19.4, 5.70, and 18.4 kg of N, P₂O₅, and K₂O, respectively.

Nutrient contributions from soil, fertiliser, and FYM were 18.2, 13.4, and 8.18 percent for N, 49.6, 11.7, and 7.87 percent for P₂O₅, and 19.4, 25.4, and 9.96 percent for K₂O, respectively. Crop requirements are satisfied to produce the highest economic yields, ensure the quality of the produce and avoid excessive levels of nutrients (Boldea *et al.*, 2015). To enhance farm productivity under different soil-climatic conditions, it is necessary to generate information on optimum nutrient doses for various crops. As the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient, soil test-based application of plant nutrients helps to realise higher response ratios and benefit:cost ratios, and the correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilisation (Rao and Srivastava, 2000).

Singh *et al.*, (2015) conducted a study During the 2013-14 growing season, researchers studied the impact of soil test crop response technologies on wheat yield and economics in five locations in the Naugarh block in Chandauli district. On the basis of the targeted yield idea, they stated that they were able to obtain targeted wheat yields of 35 q ha⁻¹ and 45 q ha⁻¹ by employing plant nutrients. The per cent increases in yield were 20.03 and 52.83% at first location, 20.03 and 52.83% at second location, 12.44 and 43.17% at third location, 16.50 and 47.84% at fourth location and 9.60 and 40.63% at fifth location with targeted yields of 35q ha⁻¹ and 45q ha⁻¹, respectively over farmers practice which were 29.66, 29.66, 31.66, 30.66 and 32.66 q ha⁻¹, respectively.

Ahmed *et al.* (2015) reported that nutrient requirement for producing one quintal of autumn rice was found to be 2.40, 0.84 and 2.25kg of N, P₂O₅ and K₂O, respectively. The per cent contribution of nutrient from soil (CS), fertilizer (CF) and FYM (CO) were calculated as 12.49, 45.31 and 32.92 for N, 13.42, 28.52 and 11.84 for P₂O₅ and 21.99, 47.58 and 29.76 for K₂O, respectively. These equations

were valid in farmer's fields throughout 2012 and also the variation between actual yield and targeted yield ranged from +1.36 to + 5.33. The fertilizer estimates under STCR – IPNS for 30 and 40 qha⁻¹ targeted yield recorded maximum response magnitude relation and economic benefit within the field trial and confirmed the validity of proposed fertilizer prescription equation for autumn rice.

It is vital to acquire information on ideal crop doses in order to increase farm profitability under various soil-climate conditions.

Tegegnetwork *et al.*, (2015) The most effective fertiliser advice should take into account crop needs as well as nutrients currently present in the soil.

Srivastava *et al.*, (2017) gave soil test based integrated nutrients requirement for cauliflower in *Vertisols* of Chhattisgarh. N, P, K requirement to produce one quintal of fresh cauliflower were 0.57, 0.10 and 0.65 kg respectively. Fertilizer and soil nutrients efficiency were estimated 41, 25, 117 percent and 17, 36, 9 percent, respectively for N, P, K. The efficiency of FYM in terms of available nutrient was evaluated as 6.75, 4.53 and 6.40%, respectively.

Vedhika, *et al.* (2017) reported that soil based fertilizer prescription for SRI rice crop on grain yield , nutrient uptake and soil test data were used for getting basic parameters viz ., nutrient requirement , contribution of nutrient from soil , fertilizer and organic manure. It was found that rice crop required 1.54kgN,0.28kg P and 1.70kg K to produce one quintal grain yield.

CHAPTER-II

MATERIAL AND METHOD

The present investigation entitled “Suitability of fertilizer recommendation equation derived for wheat crop in a *Vertisols* of farmer’s field” was carried out under farmer’s field conditions at Village/Post – Selud, Block – Patan, District – Durg (C.G.) during *Rabi* season, 2020-21. The detail of the research work carried off, materials used and methodologies adopted in this investigation are marked out in this chapter.

3.1 Geographical Location

Raipur is the capital of Chhattisgarh state and it is pin point in the center of chhattisgarh lies in the middle of 21° 16’N latitude and 81° 60’ E longitude with altitude of 289.56 meters of MSL (Mean Sea level). The Farmer’s field (Village/Post – Selud, Block – Patan, District – Durg (C.G.)) is situated 21 km away from district head quarter Durg, 9 km from Patan block/Tahsil and 33 km from Raipur district.

3.2 Meteorological Observation

Climatically, village – Selud comes under sub- humid zone, rainfall mostly comes from west monsoon (June–September). The weather data during experimental period was collected from the meteorological observatory of the Department of Agro–meteorology, IGKV, Raipur. The weekly mean meteorological data during the crop growth period is given in Appendix A and depicted in figure 3.1

3.3 Physico–chemical properties of the experimental field soil

The field experiment was conducted at farmer’s field village/post – Selud, Block- Patan, District – Durg (C.G.). The study was conducted during *Rab* season, 2020-21 in a *Vertisol* of Raipur that comes under CG plains. Representative soil sample was collected before layout of the experimental field and analysed for physico–chemical properties as mentioned in the following Table 3.1

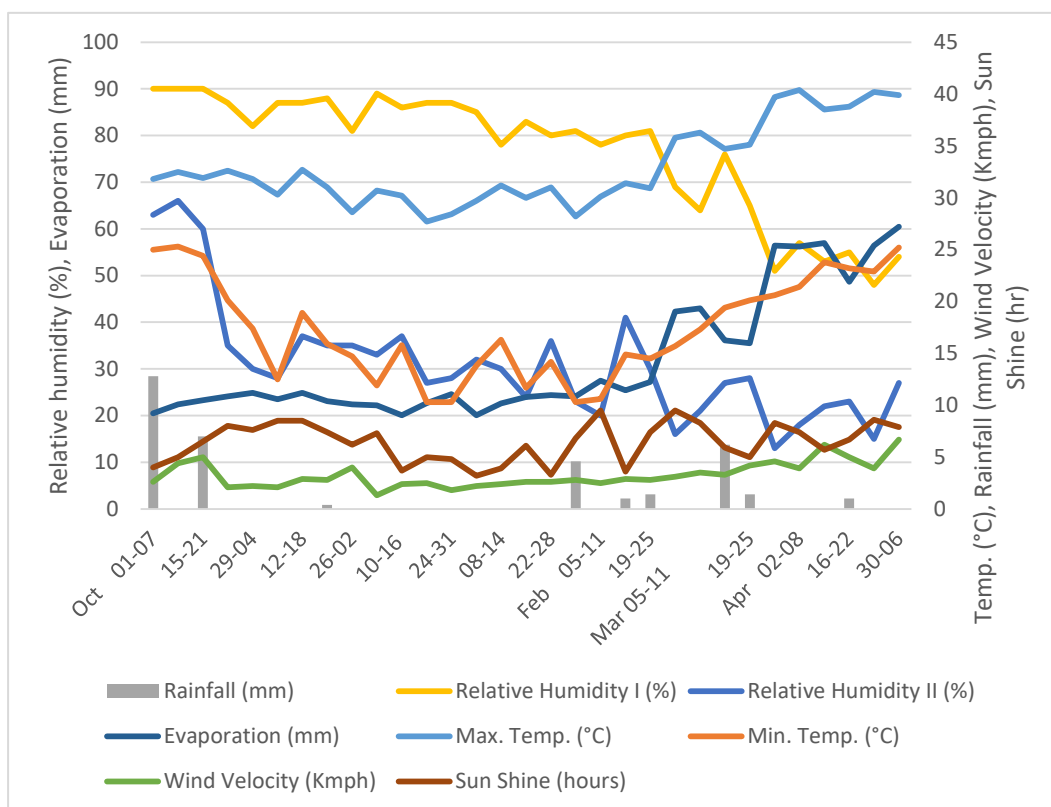


Fig 3.1: Meteorological data during the crop growth period (weekly) in Rabi 2020-21

3.1 Initial physico-chemical properties of experimental soil

	Particulars	Values	Status
	Soil textural	Clayey	<i>Vertisol</i>
	Chemical properties		
1	pH (1:2.5 soil water ratio)	7.15	Neutral
2	EC (dSm ⁻¹ 25 ^{0C})	0.10	Normal
3	Organic carbon (%)	0.37	Medium
4	Average available N (kg ha ⁻¹)	191	Low
5	Average available P (kg ha ⁻¹)	12.32	Medium
6	Average available K (kg ha ⁻¹)	569	High
7	Average available Zn (kg ha ⁻¹)	0.65	Near critical level
8	Average available S (kg ha ⁻¹)	24.55	Medium

3.4 Treatment details and layout of the experimental

Experimental details:

Location of work place	:	village –Selud
Year of study	:	2020 – 21
Season	:	Rabi
Soil	:	<i>Vertisols</i>
Crop	:	wheat <i>var.</i> (GW-366)
Plot	:	6m × 5m
Design	:	Random block design
No. of replication	:	3
No. of treatment	:	8
Date of sowing	:	20 / 10 / 2020
Date of harvesting	:	11 / 03 / 2021

Fertilizer adjustment equations for wheat (GW-273) generated in AICRP on STCR at Raipur center and were tested for their suitability on farmer's field with GW-366 variety of wheat under study. The fertilizer doses were calculated based on soil test level to achieve 25 and 35 q/ha of yield target using these formulas.

Table 3.2 Fertilizer adjustment equation

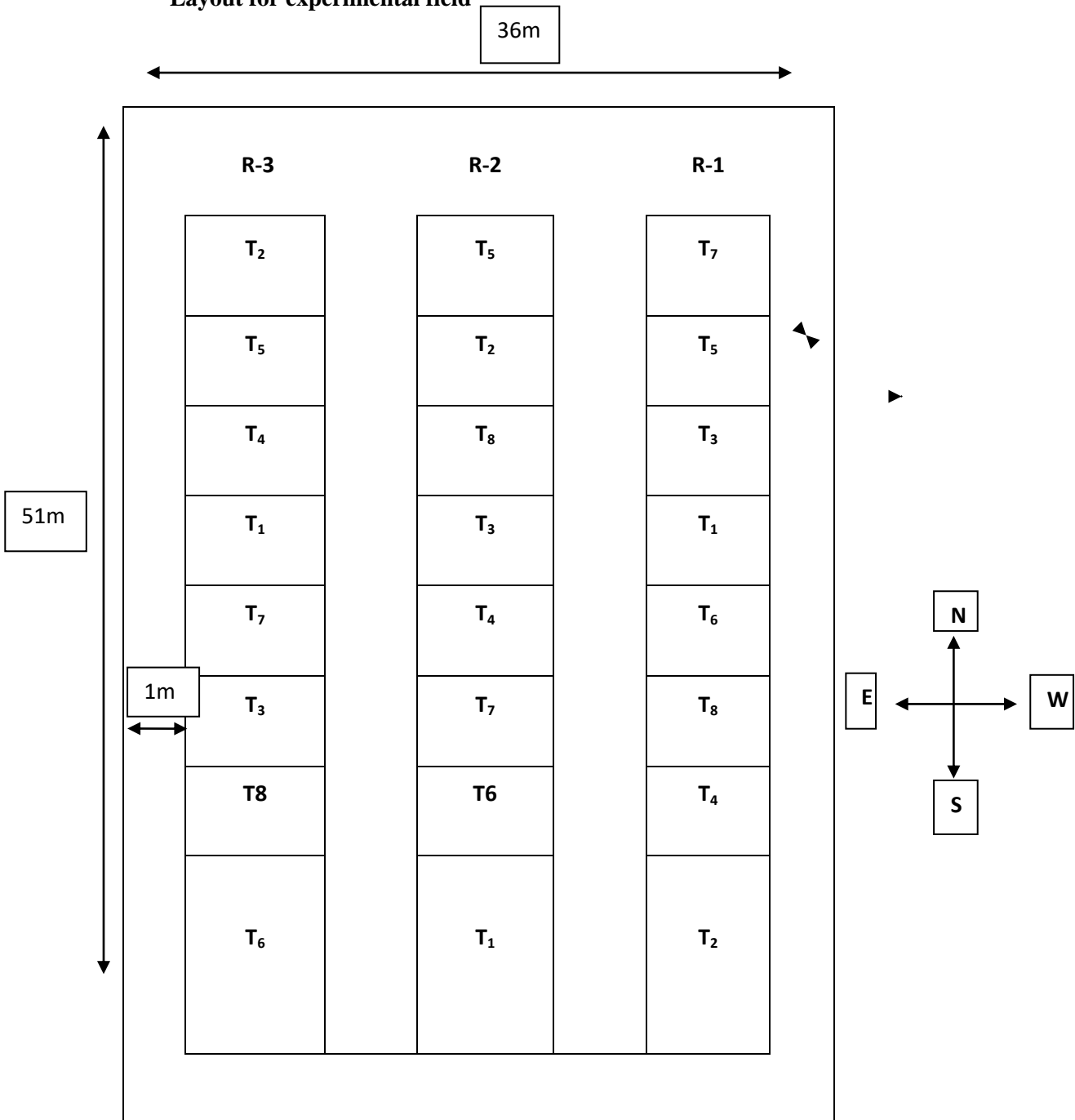
S. No.	Fertilizer adjustment equations
1	$FN = 5.75 Y - 0.32 SN - 0.25 FYM$
2	$FP = 2.55 Y - 2.51 SP - 0.21 FYM$
3	$FK = 2.88 Y - 0.09 SK - 0.05 FYM$

Treatment details

T1	Control (00: 00:00)
T2	FYM dose (@ 5 tonha ⁻¹)
T3	GRD (NPK 120: 60:40 kgha ⁻¹)
T4	N:P: K (00: 60: 40 kgha ⁻¹)
T5	N:P: K (120: 00:40 kgha ⁻¹)
T6	N:P: K (120:60: 00 kgha ⁻¹)
T7	Fertilizer dose for YT of 25q/ha (81:33:21 kgha ⁻¹ NPK)
T8	Fertilizer dose for YT of 35q/ha (139:57:50 kgha ⁻¹ NPK)

Where, GRD=General Recommended Dose (kg/ha for N, P₂O₅, K₂O), YT=Yield Target, FYM=Farm Yard Manure.

Layout for experimental field



3.5 Cultivation

3.5.1 Field preparation for wheat crop

The experimental plot was ploughed doubled by tractor drawn cultivator and levelled uniformly. After one day, bunds were prepared for individual plots as per layout plan.

3.5.2 Weed management

For the control of weeds, manual weeding was done twice at 30 DAS and 60DAS.

3.5.3 Fertilizer application

STCR and GRD based fertilizer doses were calculated and added to the respective plots. Full dose of P and K were applied in the form of DAP and MOP, respectively as basal dose at the time of sowing. Nitrogen was applied as urea in three split doses. First dose was applied as basal and remaining two doses of nitrogen were equally broadcasted at maximum tillering and panicle initiation.

3.5.4 Harvesting

The crop was harvested plot wise after maturity and bundles were labelled with treatment and replication number and kept separately for sun dry. Plot wise bundles were weighed in the field after sun dried. Threshing of sun-dried plants and winnowing of threshed plants were done manually.

3.5.5 Grain and straw yield

Grain yield was observed (kg plot^{-1}) separately for each plot and converted in to q/ha. Grain yield was recorded at 14 per cent moisture level.

3.6 Observation Recorded

3.6.1 pH

Soil pH was determined in 1:2.5 soil–water suspension after stirring for 30 minutes using glass electrode pH meter as suggested by Piper (1967).

3.6.2 Electrical conductivity

The soil samples used for pH determination were allowed to settle overnight and electrical conductivity of the supernatant liquid was determined by solu-bridge as described by Black (1965).

3.6.3 Organic carbon

Organic C was in soil samples were estimated by Walkley and Blaks's rapid titration method (1934) as described by Piper (1967).

3.6.4 Available nitrogen

Soil available N was estimated by alkaline permanganate method as described by Subbiah and Asija (1956).

3.6.5 Available phosphorus

Soil available P was extracted by 0.5M NaHCO₃ (pH 8.5) as explained by Olsen *et al.* (1954) and Phosphorus in the extract was estimated by ascorbic acid method using spectrophotometer (Watnabe and Olsen, 1965).

3.6.6 Available potassium

Soil potassium was extracted by neutral normal ammonium acetate and determined with the help of flame photometer as described by (Hanway and Heidel, 1952).

3.6.7 Available Sulphur

The available sulphur in soil was extracted by 0.15% CaCl₂.H₂O solution (Williams and Steinbergs, 1969) and content was determined by the turbidimetric method Chesnin and Turn (1950).

3.6.8 Available Zn

The available Zinc in soil was extracted using 0.005 M diethylene triamine penta acetic acid (DTPA), 0.01 M calcium chloride dihydrate and 0.1 M tri ethanol

amine (TEA) buffered at pH 7.3 (Lindsay and Norvell, 1978) and Zn content was analyzed using atomic absorption spectrophotometer (AAS).

3.7 Plant analysis

Grain and plant part like straw samples were taken after harvest and allowed to sun dry for a week, then ground with grinding machine and used for chemical analysis for different parameters as under.

3.7.1 Nitrogen content

Nitrogen content analysis in grain and plant straw samples was done by taking 1gm uniform prepared sample in digestion tube. Two gm salt mixture (K_2SO_4 and $CuSO_4 \cdot 5H_2O$ in the ratio of 9:1) and 10 ml of concentrated sulphuric acid were added and material was digested at $350\text{ }^\circ\text{C}$ in digestion block till the content becomes colourless. Then nitrogen in digested material was distilled by KEL plus system.

3.7.2 Phosphorus and potassium

Half gram of grain and plant straw samples were taken in digestion tube and 10 ml of di-acid mixture (Concentrated HNO_3 and $HClO_4$ in the ratio of 9:4) was added. The material was digested at $150\text{ }^\circ\text{C}$ in KEL plus digestion block till the material become colourless. The digested material was transferred into 100 ml volumetric flask by repeated washing with distilled water and made up the volume up to the mark. The digested material was used for the estimation of P and K content analysis as given below:

3.7.2.1 Phosphorus content

Phosphorus content was determined by vanado-molybdate-phosphoric acid yellow reagent complex method as described by Jackson (1973). An aliquot of 5 ml was taken into 50 ml volumetric flask. To this, 10 ml of vanado-molybdate yellow reagent was added and volume was made up to the mark. After half an hour, yellow colour was developed and the intensity of this colour was measured by Spectrophotometer.

3.7.2.2 Potassium content

K content was estimated by flame photometer as described by Chapman and Pratt (1961). An aliquot of 5 ml was taken in to 25 ml volumetric flask and K content was estimated by flame-photometer.

3.8 Nutrient uptake

Nitrogen, phosphorus and potassium uptake in grain and straw were computed by multiplying their respective nutrient content with yield using of following formula: Nutrient uptake (kg ha^{-1}) in grain and straw = Grain and straw yield x Nutrient Content.

3.9 Nutrient requirement and efficiencies of nutrients from different sources: -

These parameters were calculated by using the following formula

$$1. \text{ Nutrient requirement as kg/q grain production} = \frac{\text{Total nutrient uptake (kg/ha)}}{\text{Grain yield (q/ha)}}$$

$$2. \text{ Efficiency of Soil Nutrients} = \frac{\text{Total nutrient uptake (kg/ha) from control plot}}{\text{Soil available nutrients (kg ha}^{-1}\text{)}}$$

$$3. \text{ Efficiency of Fertilizer nutrients} = \frac{\text{Total nutrient uptake from treated plot} - \text{Total uptake from control plot (kg/ha)}}{\text{Fertilizer nutrient applied (kg/ha)}}$$

$$4. \text{ Efficiency of FYM nutrients} = \frac{\text{Total nutrient uptake from FYM treated plot} - \text{Total nutrient uptake from control plot (kg/ha)}}{\text{Total nutrient content in FYM applied (kg/ha)}}$$

3.10 Statistical analysis

The experiment was outlaid in Randomized Block Design (RBD). All data sets were analyzed using analysis of variance (ANOVA) as described by Gomez and Gomez (1984). The level of significance used in “F” test was given at 5%. Critical difference values have been given in the table at 5% level of significance. The skeleton of analysis of variance and formula used for various estimations are given below:

Table 3.3: The skeleton of the analysis of variance

<u>Source of variation</u>	<u>DF</u>	<u>SS</u>	<u>MSS</u>	<u>F cal</u>	<u>F tab (5%)</u>
Replication (r)	(r-1)	RSS	RMS	RMS/EMS	
Treatment (t)	(t-1)	TrSS	TrMS	TrMS/EMS	
Error	(r-1)(t-1)	ESS	EMS	-	
<u>Total</u>	<u>rt-1</u>	<u>TSS</u>	<u>-</u>	<u>-</u>	

The following formula was used for standard error, critical difference and coefficient of variance estimations:

$$(a) \text{ SE } m_{\pm} = \sqrt{EMS/r}$$

$$(b) \text{ CD} = \text{SE}(m) \times \sqrt{2} \times t \text{ value at 5\% error (df)}$$

$$(c) \text{ CV (\%)} = \sqrt{SEM/GM} \times 100$$

Where,

R = No. of replication

MSS = Mean sum of square

T = No. of treatments

SE_{m±} = Standard error of mean

DF = Degree of freedom

EMS = Error mean squares

SS = Sum of square

CD = Critical difference

CHAPTER- IV

RESULTS AND DISCUSSION

This chapter presents the results of experiment conducted on “Suitability of fertilizer recommendation equation derived for wheat crop in a *Vertisol* of farmer’s field” at village Selud, block Patan, district – Durg of Chhattisgarh state during Rabi season, 2020. The results obtained over the season on various parameters have been presented and discussed under the following heads:

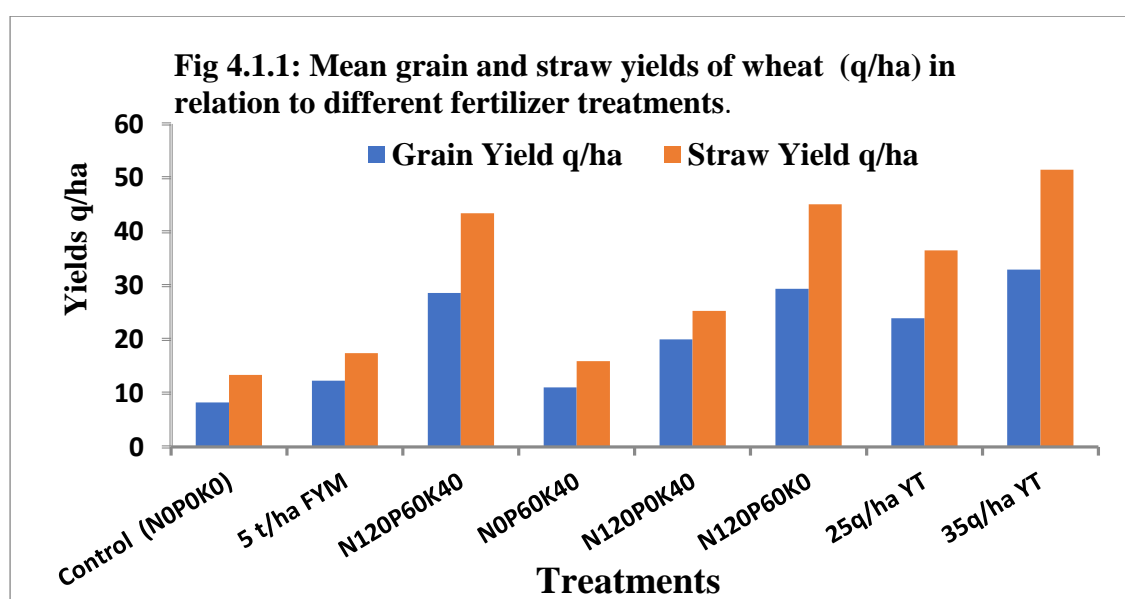
4.1: Grain and straw yield of wheat

Results presented in the Table 4.1.1 and Fig. 4.1.1 reveal that average grain and straw yields of wheat in relation to different fertilizer treatments application. The objective of the experiment was to test the suitability of soil test based fertilizer equations derived for wheat crop during previous season. It is clear from the results that application of soil test based fertilizer N P K yielded less than the targeted crop yield however, the yields achieved were within the limitation of $\pm 10\%$ variation. Application of soil test based fertilizer dose to achieve a yield target of 35 q/ha produced significantly highest yield followed by blanket recommendation of NPK @ 120:60:40 kg/ha and was at par with that of same dose of N and P application without K. This indicated no crop response to K application due to well supply of K by the soil under study i.e. *Vertisol*. Grain yield was significantly higher by the application of FYM over control and was at par with T4 treatment that received only P and K. This shows the importance of N nutrition with which yield could be tremendously increased by two and half folds if N is included with P and K application (T3) in a balanced manner. On the other hand, if P was omitted as in case of T5 treatment, considerable yield can be achieved. This result could be achieved due to medium level of soil P status under study. Straw yields of wheat crop also performed in a similar manner as that of with grain yields.

Based on the results, it can be concluded that fertilizer doses applied on the basis of soil test level of experimental field soil, the fertilizer prescription equation derived for

Table 4.1.1: Average grain and straw yields of wheat in relation to different Fertilizer treatments

S. No.	Treatments	Grain yield (q/ha)	Straw yield (q/ha)
T ₁ .	Control (N ₀ P ₀ K ₀)	8.30f	13.40e
T ₂ .	FYM @ 5t/ha	12.33 e	17.45 e
T ₃ .	N ₁₂₀ P ₆₀ K ₄₀	28.60 b	43.42 b
T ₄ .	N ₀ P ₆₀ K ₄₀	11.08 e	15.98 e
T ₅ .	N ₁₂₀ P ₀ K ₄₀	19.99 d	25.30 d
T ₆ .	N ₁₂₀ P ₆₀ K ₀	29.37 b	45.08 b
T ₇ .	Fertilizer dose for yield target of 25q/ha (81:32:21 kg/ha NPK/FYM)	23.92 c	36.50 c
T ₈ .	Fertilizer dose for yield target of 35q/ha (139:57:50 kg/ha NPK/FYM)	32.94 a	51.50 a
Mean		20.82	31.08
SEm±		0.89	1.44
CD		2.71	4.37
CV		7.44	8.03



wheat crop during previous season is valid on the farmer's field. Many workers also have tested the STCR equation derived for various crops and found valid with $\pm 10\%$ variation.

4.2. Nutrients uptake and efficiencies.

4.2.1: Nitrogen Uptake in grain, straw and total

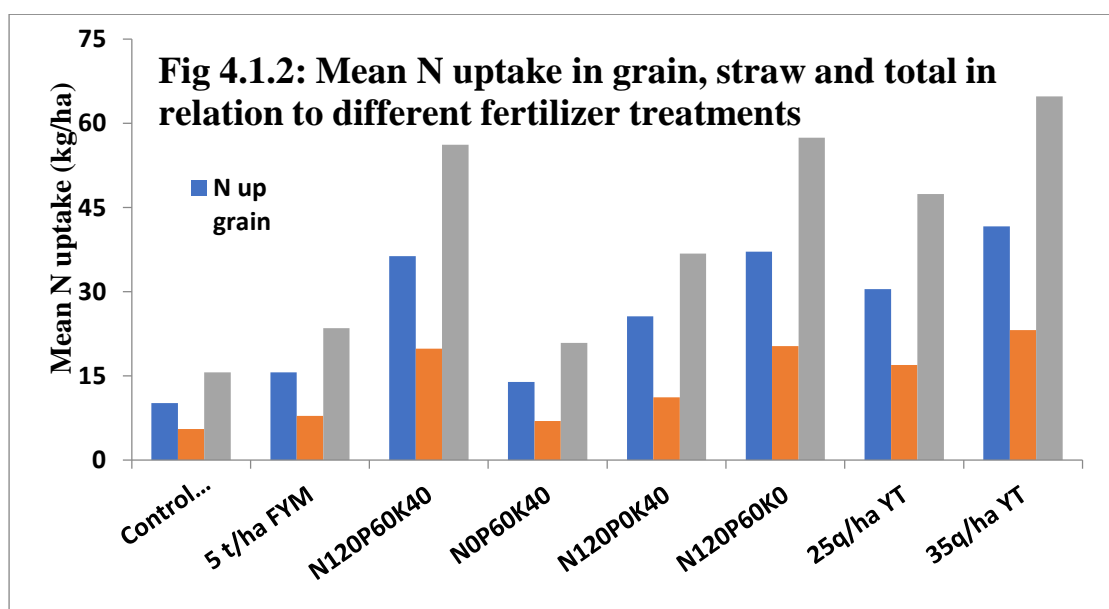
Table 4.1.2 and Fig. 4.1.3 show the N uptake by wheat grain, straw and their total. Nitrogen uptake by grain, straw and their total significantly affected by different fertilizer treatments. Highest N uptake was observed in the treatment that received fertilizer application for yield target of 35 q/ha which was statistically at par with the treatments T3 and T6 that received RDF with or without K application. Similarly, N uptake in wheat straw also differed significantly with different fertilizer treatments with FYM application. Like N uptake in grain, highest N uptake in straw was recorded in the Treatment that received fertilizer application for yield target of 35 q/ha which was statistically at par with the treatments T3 and T6 that received RDF with or without K application. Similar trends were also recorded with total N uptake by wheat crop.

The N uptake was increased due to the better availability of nitrogen in soil and their transport to the plant from the soil and availability of nitrogen enhanced by application of higher doses of fertilizer. The per cent increase in N uptake by different fertilizer and manurial treatment was 93 to 195% in rice as reported by Bhandari *et al.* (1992).

Table 4.1.2: Mean Nitrogen uptake (kg/ha) in grain, straw and total in relation to different fertilizer treatments

S. No.	Treatments	Grain	Straw	Total
T ₁ .	Control (N ₀ P ₀ K ₀)	10.13d	5.50c	15.63f
T ₂ .	FYM @ 5t/ha	15.60d	7.88c	23.48e
T ₃ .	N ₁₂₀ P ₆₀ K ₄₀	36.32a	19.83a	56.15b
T ₄ .	N ₀ P ₆₀ K ₄₀	13.92	6.94c	20.87e
T ₅ .	N ₁₂₀ P ₀ K ₄₀	25.59bc	11.16bc	36.75d
T ₆ .	N ₁₂₀ P ₆₀ K ₀	37.10ab	20.30a	57.39b

T ₇ .	Fertilizer dose for yield target of 25q/ha (81:32:21 kg/ha NPK/FYM)	30.45b	16.90ab	47.35c
T ₈ .	Fertilizer dose for yield target of 35q/ha (139:57:50 kg/ha NPK/FYM)	41.62a	23.15a	64.77a
Mean		26.34	13.96	40.30
SEm±		1.10	0.62	1.54
CD		3.25	1.88	4.68
CV		7.04	7.69	6.63

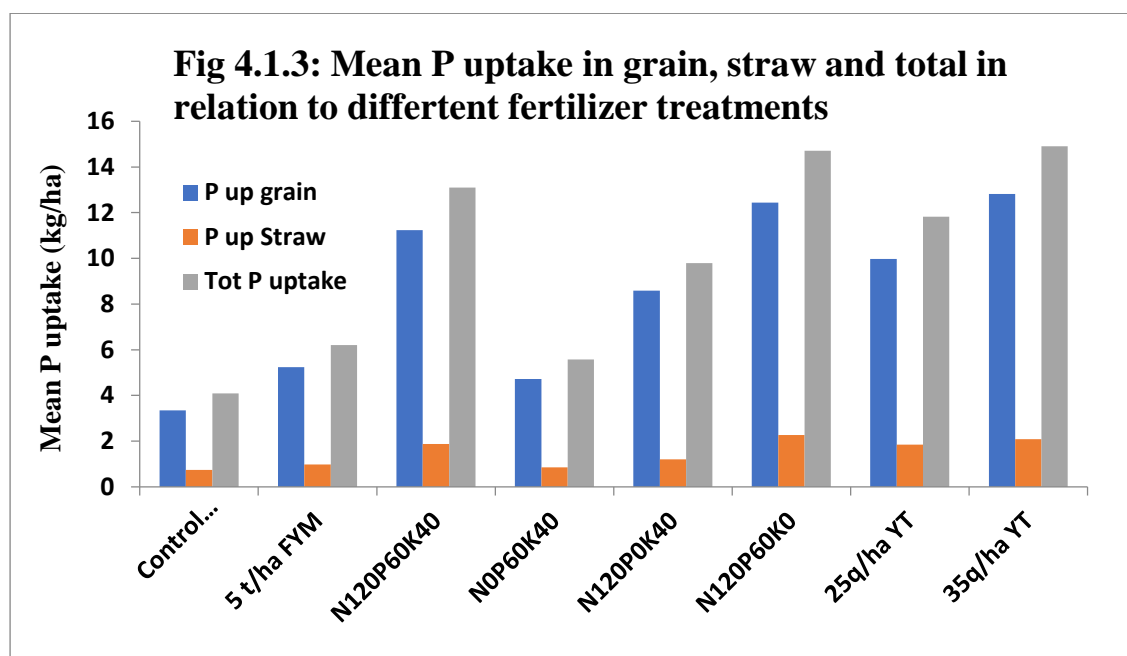


4.2.2: Phosphorus Uptake in grain, straw and total

Results on phosphorus uptake by wheat in grain, straw and their total are given in the Table 4.1.3 and depicted in Fig. 4.1.3 show that P uptake significantly affected with different fertilizer treatments. Highest P uptake was observed by the crop in grain, straw and their total P uptake. Grain and straw P uptake were statistically at par with the treatment T3 that received recommended dose of fertilizer and T6 without potassium application. However, the total P uptake by the crop was significantly higher with the treatment T8 followed by T3 and T6. Minimum P uptake was recorded in control treatment. P uptake in T2 and T4 that received application of 5 t/ha FYM and N₀P₆₀K₄₀ showed at par results.

Table 4.1.3: Mean Phosphorus uptake (kg/ha) in grain, straw and total in relation to different fertilizer treatments

S. No.	Treatments	Grain	Straw	Total
T ₁ .	Control (N ₀ P ₀ K ₀)	3.35f	0.74c	4.09f
T ₂ .	FYM @ 5t/ha	5.24e	0.97c	6.21e
T ₃ .	N ₁₂₀ P ₆₀ K ₄₀	11.23b	1.87b	13.10b
T ₄ .	N ₀ P ₆₀ K ₄₀	4.71e	0.85c	5.57e
T ₅ .	N ₁₂₀ P ₀ K ₄₀	8.59d	1.20c	9.79d
T ₆ .	N ₁₂₀ P ₆₀ K ₀	12.44a	2.27a	14.70a
T ₇ .	Fertilizer dose for yield target of 25q/ha (81:32:21 kg/ha NPK)	9.97c	1.85b	11.82c
T ₈ .	Fertilizer dose for yield target of 35q/ha (139:57:50 kg/ha NPK)	12.82a	2.08a	14.91a
	Mean	14.43	2.52	10.02
	SEM±	0.25	0.17	0.31
	CD	0.77	0.52	0.92
	CV	3.05	11.73	5.26

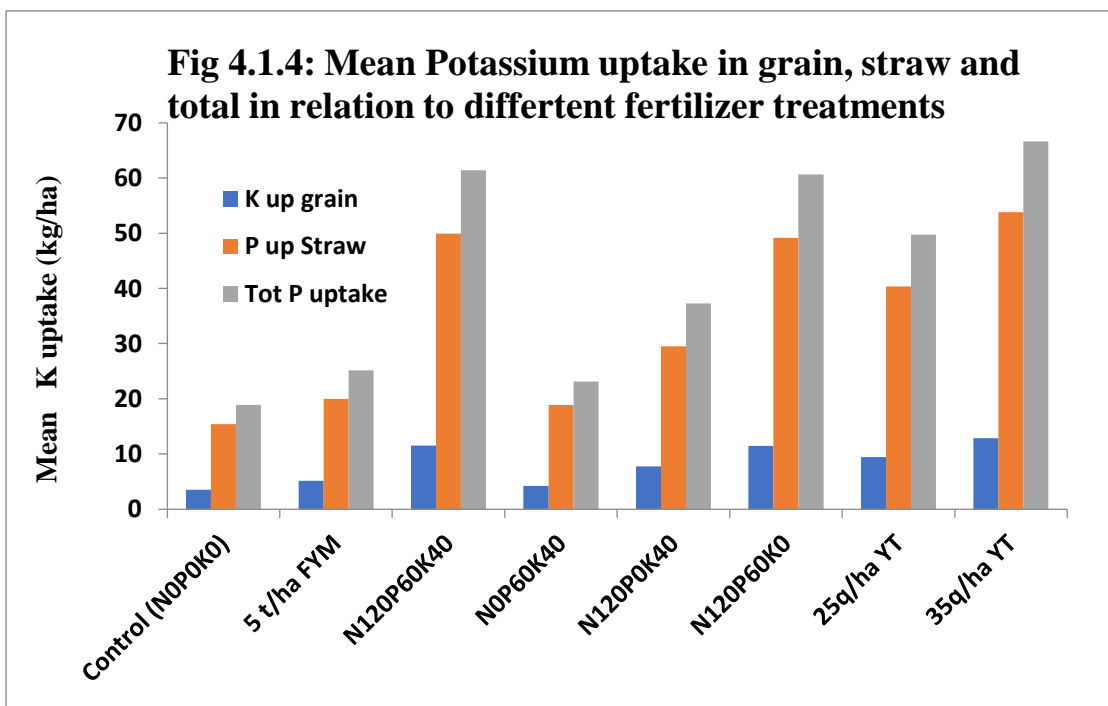


4.2.3: Potassium uptake in grain, straw and total

Results presented in Table 4.2.3 and Fig 4.1.4 revealed that K uptake in grain, straw and their total significantly differed by different fertilizer application. Treatment that received fertilizer application based on soil test to achieve a yield target of 35 q/ha recorded highest K uptake which was statistically at par with T3 and T6 that received recommended dose of fertilizer with K or without K in case of K uptake in straw as well as in total K uptake. K uptake was found to be higher in straw part as compared to grain part. K uptake followed with grain and straw yield of wheat as it is a multiple of content and yield. Control treatment had lowest K uptake significantly to other fertilizer treatments.

Table 4.1.4: Mean Potassium uptake (kg/ha) in grain, straw and total in relation to different fertilizer treatments

S. No.	Treatments	Grain	Straw	Total
T ₁ .	Control (N ₀ P ₀ K ₀)	3.51f	15.40e	18.91e
T ₂ .	FYM @ 5t/ha	5.16e	20.00d	25.16d
T ₃ .	N ₁₂₀ P ₆₀ K ₄₀	11.52b	49.90a	61.42a
T ₄ .	N ₀ P ₆₀ K ₄₀	4.21	18.91de	23.12d
T ₅ .	N ₁₂₀ P ₀ K ₄₀	7.78d	29.52c	37.29c
T ₆ .	N ₁₂₀ P ₆₀ K ₀	11.44b	49.18a	60.62a
T ₇ .	Fertilizer dose for yield target of 25q/ha (81:32:21 kg/ha NPK/FYM)	9.43c	40.33b	49.76b
T ₈ .	Fertilizer dose for yield target of 35q/ha (139:57:50 kg/ha NPK/FYM)	12.86a	53.78a	66.64a
Mean		8.24	34.63	42.87
SEm±		0.42	1.66	1.91
CD		1.26	5.04	5.81
CV		8.75	8.31	7.74



4.2.4: Nutrient requirement, efficiencies of fertilizer, soil test and FYM.

Nutrient requirement as kg per quintal of grain production, efficiencies of fertilizer nutrients, soil nutrients and organic nutrients are the basic parameters that can be estimated from nutrients omission treatments as under

Table 4.1.5: Nutrient requirements, fertilizer, soil and FYM nutrients efficiencies estimated under study for wheat (GW-366)

Nutrients	Nutrient Requirement (kg q ⁻¹)	Fertilizer use efficiency (%)	Soil test use efficiency (%)	FYM nutrients use efficiency (%)
N	1.92	31.10	8.20	31.4
P	0.47	15.40	28.5	14.13
K	2.04	140.2	3.30	15.61
Nutrient content in FYM		0.5% N, 0.30 % P and 0.8 % K		

The amount of nutrients absorbed by the crop decides a definite amount of biomass production. The amount of nutrient required to produce one quintal of wheat grain yield was found to be 1.92 kg N, 0.47 kg P and 2.04 kg K. The nutrient requirement was estimated using the conventional method as given below:

$$\text{NR (kg/q)} = \frac{\text{Total Nutrient Uptake (kg/ha)}}{\text{Grain Yield}}$$

Several workers have reported the nutrient requirement of different crops at various places. Ramamoorthy and Dinesh (1967) reported for wheat crop which required 2.5 kg N, 0.35 kg P and 0.83 kg K for one quintal of grain production. Stanford *et al.*, (1965) reported for sugarcane crop as 0.91 kg N uptake to produce a ton of net cane. Prasad *et al.* (1981) estimated the nutrient requirement of sugarcane at Sugarcane Research Institute, Pusa, Bihar, for the production of 1 ton of cane as 1.71 kg N, 0.18 kg P₂O₅ and 1.80 kg K₂O.

The efficiencies of fertilizer, soil test and FYM were estimated by using the conventional methods with the help of conventional formula given in the chapter of materials and methods. Table 4.1.5 gives the results for wheat. The fertilizer efficiencies of N, P and K for wheat crop were estimated as 31.10, 15.40 and 140.2 per cent, respectively. Similarly, the efficiencies of soil test for wheat were recorded as 8.20 % N, 28.5% P and 3.30% K. The efficiencies of nutrients from organic source (FYM) were observed as 31.4% N, 14.13% P and 15.61% K for wheat crop under testing. FYM used under study was analyzed for total N, P and K content as shown in Table 4.1.5. The nutrient contents were recorded 0.45 % N, 0.35% P and 0.87 % K. The FYM used had low nutrients value than the standard values

It is estimated fact that about 2/3rd of the applied fertilizer N lost through leaching, volatilization, de-nitrification and by run-off. Similarly, a large fraction of applied fertilizer P is fixed in soil by reacting with dominant cations present in the soil like Fe, Mn, Ca, Mg etc. Very high efficiency of applied fertilizer K (more than 100%) observed under study seems to be due to higher uptake of this nutrient as luxury consumption and high status of native soil K of the experimental field's soil hence almost no crop response to applied fertilizer K was observed. This very high

efficiency of applied fertilizer K can be treated as indefinable. Soil test efficiencies for N and K were recorded less than fertilizer sources and reverse trend was seen in case of soil test P. Ramamoorthy *et al.* (1967) reported the efficiency of soil N, P and K were 37, 14 and 44.0 per cent, respectively and the efficiency of fertilizer N, P and K were 34, 41 and 36 per cent, respectively. Similar results were reported by Santhi *et al.* (2004) where the contribution of soil and fertilizer nutrients as 14.13 and 38.28 per cent for N, 35.33 and 56.61 per cent for P₂O₅ and 14.33 and 70.03 per cent for K₂O, respectively for onion bulb yield in *Inceptisols* of Tamil Nadu.

Table 4.1.6: Apparent recovery of fertilizer nutrients in relation to blanket and soil test based fertilizer application in wheat

Treatments	Nutrients→	N	P	K
Recommended Dose of Fertilizer (120:60:40 kg/ha NPK)		0.290	0.130	1.280
Yield target Of 25q/ha (81:32:21 kg/ha NPK)		0.327	0.145	1.770
Yield target of 35q/ha (139:57:50 kg/ha NPK)		0.317	0.186	1.156
Mean		0.311	0.154	1.402

Table 4.1.6 gives the comparison of apparent recovery of fertilizer nutrients (fertilizer Use Efficiency) with respect to soil test based fertilizer application to achieve a definite yield goal of the crop i.e. 25 and 35 q/ha and general recommended dose of fertilizer. The results clearly indicate that soil test based fertilizer application provides a balanced fertilization based on the crop nutrients requirement, and efficiencies of different nutrients sources. Hence, yield target based fertilizer application for a definite yield targets have recorded higher efficiencies particularly for applied N and P in comparison to that of recommended dose of fertilizer. (Shekhonet *al.*(1990); Verma and Singh (1990); Chand (1993); Dhillon (1995); Velayuthan (1979) revealed that this approach provided scientific basis for balanced fertilization.



CHAPTER-V

SUMMARY, CONCLUSIONS AND SUGGESTION FOR FUTURE RESEARCH WORK

This chapter presents the summary of experiment conducted on “**Suitability of fertilizer recommendation equation derived for wheat crop in a Vertisol of farmer’s field**” at village-Selud, block-Patan, district – Durg of Chhattisgarh state during Rabi season, 2020. The results obtained from the experiment on various parameters have been briefly summarized and concluded in this chapter.

The salient finding of the present investigation are summarized below:

- Application of soil test-based fertilizer N, P and K yielded less than the targeted crop yield however, the yields achieved were within the limitation of $\pm 10\%$ variation. Application of soil test-based fertilizer dose to achieve a yield target of 35 q/ha produced significantly highest yield followed by blanket recommendation of NPK @ 120:60:40 kg/ha and was at par with that of same dose of N and P application without K. This indicated, no crop response to K application due to well supply of K by the soil under study *i.e. Vertisol*.
- Grain yield was significantly higher by the application of FYM over control and was at par with T4 treatment that received only P and K. This shows the importance of N nutrition with which yield could be tremendously increased by two and half folds if N is included with P and K application (T3) in a balanced manner.
- If P was omitted as in case of T5 treatment, considerable yield can be achieved. This result could be achieved due to medium level of soil P status under study.
- Straw yields of wheat crop also performed in a similar manner as that of with grain yields.

- Highest N uptake was observed in the treatment that received fertilizer application for yield target of 35 q/ha which was statistically at par with the treatments T3 and T6 that received RDF with or without K application. Similarly, N uptake in wheat straw also differed significantly with different fertilizer treatments with FYM application.
- Grain and straw P uptake were statistically at par with the treatment T3 that received recommended dose of fertilizer and T6 without potassium application. However, the total P uptake by the crop was significantly higher with the treatment T8 followed by T3 and T6. Minimum P uptake was recorded in control treatment.
- Treatment that received fertilizer application based on soil test to achieve a yield target of 35 q/ha recorded highest K uptake which was statistically at par with T3 and T6 that received recommended dose of fertilizer with K or without K in case of K uptake in straw as well as in total K uptake.
- The amount of nutrient required to produce one quintal of wheat grain yield was found to be 1.92 kg N, 0.47 kg P and 2.04 kg K. The fertilizer efficiencies of N, P and K for wheat crop were estimated as 31.10, 15.40 and 140.2 per cent, respectively. Similarly, the efficiencies of soil nutrients for wheat were recorded as 8.20 % N, 28.5% P and 3.30% K. The efficiencies of nutrients from organic source (FYM) were observed as 31.4% N, 14.13% P and 15.61% K for wheat crop in *Vertisol* under testing.
- Result indicate that soil test-based fertilizer application provides a balanced fertilization based on the crop nutrients requirement, and efficiencies of different nutrients sources. Hence, yield target based fertilizer application for a definite yield targets have recorded higher efficiencies particularly for applied N and P in comparison to that of recommended dose of fertilizer

Conclusion: -

1. The importance of N nutrition with which yield could be tremendously increased by two and half folds if N is included with P and K application (T3) in a balanced manner. On the other hand, if P was omitted as in case of T5 treatment, considerable yield can be achieved.

2. N uptake in wheat straw also differed significantly with different fertilizer treatments with FYM application.
3. The total P uptake by the crop was significantly higher with the treatment T8 followed by T3 and T6. Minimum P uptake was recorded in control treatment. P uptake in T2 and T4 that received application of 5 t/ha FYM and $N_0P_{60}K_{40}$ showed at par results.
4. Highest K uptake which was statistically at par with T3 and T6 that received recommended dose of fertilizer with K or without K in case of K uptake in straw as well as in total K uptake.
5. It indicates that soil test-based fertilizer application provides a balanced fertilization based on the crop nutrients requirement, and efficiencies of different nutrients sources.

SUGGESTION FOR FUTURE RESEARCH WORK

1. The current investigation should be repeated for at least two or three successive years for reliable conclusions and recommendations.
2. There is a possibility to test the variety with same treatments under different soil conditions to have comprehensive outcome.

REFERENCES

- Apoorva, K.B., Prakash, S.S., Rajesh, N.L., Nandini, B. 2010. STCR Approach for optimizing integrated plant nutrient supply on growth, yield and economics of finger millet (*Eleusine coracana* (L.) Gaertn.), *EJBS* 4(1):19-27.
- Banerjee, H. and Pal, S. 2009. Integrated nutrient management for rice-rice cropping system. *Oryza*, 46 (1) 32-36.
- Brajendra, Patiram and Singh, L. S. 2012. Soil test based fertilizer recommendation and verification for maize grown in mid hills of Meghalaya. *An Asian Journal of Soil Science*, 7(1):124-126.
- Bhandari, A. L., Sood. A., Sharma, K. N. and Rana, D. S. 1992. Integrated nutrient management in a rice-wheat system. *J. Indian Soc. Soil. Sci.* 40 (4): 742-747.
- Bhaduri, D and Gautam, P. 2012. Balanced use of fertilizers and FYM to enhance nutrient recovery and productivity of wheat (*Triticum aestivum* cv UP-2832) in Mollisols of Uttarakhand. *International Journal of Agriculture, Environment and Biotechnology* 5: 435-439.
- Bhatt, B., Chandra, R. and ShriRam 2012. Long-term application of fertilizer and manure on rice productivity and soil biological properties. *International Journal of Agriculture Environment and Biotechnology* 5: 429-433.
- Black, C. A. 1965. *Methods of Soil Analysis*. Amer. Soc.of Agro. Inc. Publ. Madison, Wisconsin, USA.
- BoldeaM, Sala F, Rawashdeh H, Luchian D. Evaluation of agricultural yield in relation to the doses of mineral fertilizers. *J Central European Agric.* 2015; 16:149-61.
- Chand, M. 1993. Soil test crop response Correlation studies for efficient management of nutrients under intensive agriculture, In: Annual Report STCR- 1993-98 IISS Bulletin. pp. 79-82.
- Chen, S., X. Zhang, H. Sun, T. Ren and Y. Wang. 2010. Effects of winter wheat row spacing on evapotranspiration, grain yield and water use efficiency. *Agricultural Water Management* 97: 1126-1132.
- Chapman, H. D. and Pratt, P. F. 1961. *Soil water and plant analysis*. In. Univ. California Agri. Div. Publisher.

- Dhillon N.S., Vig A.C. and Brar J.S. 1997. Soil test based target yield approach to formulating crop fertilization programme in Punjab. *Journal of Research, Punjab Agricultural University*, 34(4): 384-392.
- Fitts, J.W. and Nelson, W.L. 1956. The determination of time and fertilizer requirement of soil through chemical tests. *Advan. Agron.* 8: 241-283.
- Gangola, P., Singh, R., Bhardwaj, A.K. and Gautam, P. 2012. Effect of moog straw on soil properties under INM in long-term ricewheat cropping system in a Mollisol. *International Journal of Agriculture Environment and Biotechnology* 5: 281-186.
- Gupta V, Sharma R.S. and Vishvakarma S.K. 2006. Long-term effect of integrated nutrient management on yield sustainability and soil fertility of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy*, 51: 160-164.
- Hiltbrunner, J., B. Streit and M. Liedgens. 2007. Are seeding densities an opportunity to increase grain yield of winter wheat in a living mulch of white clover? *Field Crop Res.* 102: 163-171.
- Jadhav AD, Talashilkar SC, Power AG (1997). Influence of conjunctive use of FYM, vermicompost and urea on growth and nutrient uptake in rice. *J. Maharastra Agric. Uni.* 22:249-250.
- Jackson, M. L. 1973. *Soil Chemical Analysis*. Prentice-Hall of India Pvt Ltd., New Delhi.
- Kanwar, J.S. 1971. Soil fertility evaluation. IN. *Proc. Int. Symp. Soil fertility Evaluation*, New Delhi. 1 (1): 1103-113.
- Ladha, K.C. and Totawat, K.L. 1990. Interactive effect of tillage and phosphorus fertilizer in conjunction with FYM to sorghum + green gram intercropping system on performance of crops. *Annals of Arid Zone*, 37:373-24.
- Lindsey, W.L. and Norvell, W.A. 1978. Development of a DTPA test for zinc, iron, manganese and copper. *Soil Sci. Soc. of Amer. J.*, 42:421-428.
- Meena, M., Ahmed, S., Riazuddin, M., Chandrasekhara, K. R. and Rao, B.R.C.P. 2001. Soil test crop response calibration studies on onion (*Allium cepa*) in Alfisols. *J. Indian Soc. Soil Sci.*, 49 (4):709-713.
- Melsted, S.W. and Peck, T.R. 1973. The Mitscherlich- Bray growth functions Soil testing correlation and interpretation analytical results. *Amer. Soc. of Agron.* **29**: 1-18.
- Mitscherlich and Baule (1961). Status and methods of research in economic and agronomic aspects of fertilizer response and use. National Academy of

Sciences- National research Council, 2101. Constitution Avenue, Washington, D.C.

- Olsen, S.R., Cole, C.V., Watnable, F.S. and Dean, L.A. 1954. Estimation of available phosphorous in soils by extraction with sodium carbonate. U.S.D.A. Cir. No. 933:1-10.
- Parihar, S.S. 2004. Effect of crop-establishment method, tillage, irrigation and nitrogen on production potential of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy*. 49(1): 1-5.
- Prasad, J., Karmakar, S., Kumar R. and Mishra, B. 2010. Influence of integrated nutrient management on yield and soil properties in maize-wheat cropping system in a Alfisol of Jharkhand. *Journal of the Indian Society of Soil Science*, 58 (2): 200-204.
- Piper, C.S. 1966. *Soil and Plant Analysis*. Hans Publisher, Bombay pp. 85-102.
- Puri G. and Bhargava, O. D. 2001. Nutrient management for rice, based on targeted yield concept in medium black soil of Satpura and Kaymore plateau in Madhya Pradesh., *JNKVV Research Journal*. 35: 8-11.
- Rajput, S.C. 2008. Effect of integrated nutrient management on productivity and monetary returns of pearl millet (*Pennisetum glaucum*). *Research on Crop*, 9: 248-250.
- Ramamoorthy, B., Narasimhan, R.L. and Dinesh, R.S. 1967. Fertilizer application for specific yield targets of Sonara-64. *Indian Farming*. 17 (5): 43-45.
- Rao S, Srivastava S. Soil test based fertilizer use-a must for sustainable agriculture. *Fertilizer News*. 2000; 45:25- 38.
- Sahu V, Srivastava LK, Mishra VN. 2017 Soil test based fertilizer prescriptions through integrated nutrient management using targeted yield approach for SRI rice (Var. Swarna) in Vertisols of Chattisgarh, India. *International Journal of Current Microbiology and Applied Sciences*.; 6:2824-2835.
- Santhi, R., Bhaskaran, A. and Natesan, R. 2011. Integrated fertilizer prescriptions for beetroot through inductive cum targeted yield model on an alfisols. *Communications in Soil and Plant Analysis* 42: 1905-1912.
- Santhi, R., Natesan, R., Andi, K. and Selvakumari, G. 2004. Soil test based fertilizer recommendation for sunflower. (*Helianthus annuus* L). in *Inceptisols of Tamilnadu. J. Oil Seed Res.* 21 (1): 78-81.
- Sharma, B. M. and Singh, R. V. 2000. Fertilizer recommendations for wheat based on regression and targeted yield approach— A comparison. *J. Indian Soc. Soil. Sci.* 396-397.

- Sharma, G. K., Mishra, V. N., Maruti Sankar, G. R., Patil, S. K., Srivastava, L. K., Thakur, D. S. and Srinivasa Rao, Ch. 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): 2177-2190.
- Singh, Y. V., Dey, Pradeep, Singh, S.K. and Kumar, Mukesh 2015. Impact of soil test crop response technology on yield and economics of wheat in chandauli district of Uttar Pradesh. *Technofame*, 4(1): 52-56.
- Singh, K.N., B.Prasad and S.K.Sinha 2001. Effect of integrated nutrient management on a Typic Haplaquent on yield and nutrient availability in a rice-wheat cropping system. *Aus. J. of Agric. Res.*, 52: 855-858.
- Subba Rao, A. and Srivastava, Sanjay 2000. Soil test based fertilizer use-a must for sustainable agriculture. *Fert. News*, 45 (2): 25-38.
- Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for estimation of available nitrogen in soils. *Curr. Sci.* 25: 259-260.
- Suri, V. K., Verma, T. S., Jaipal and Sanjeev Sandal 2005. Validation of fertilizer adjustment equation based on targeted yield concept for rainfed soybean grown under wet temperate zone of Himachal Pradesh. *Crop Res.*, 29 (3): 411-415.
- Sushila, R. and Giri, G. 2000. Influence of farmyard manure, nitrogen, and biofertilizers on growth yield attributes and yields of wheat under limited water supply. *Indian Journal of Agronomy*, 45: 590-595.
- Swarup, Anand 2002. Lessons from long-term fertilizer experiments in improving fertilizer use efficiency and crop yields. *Fertilizer News*, 47 (12): 59-73.
- Swarup, Anand 2010. Integrated plant nutrient supply and management strategies for enhancing soil quality; input use efficiency and crop productivity. *Journal of the Indian Society of Soil Science*, 58 (1): 25-31.
- Tamboli, B. D.; Patil, Y. M., Bhakhare, B. D. and Sonar, K. R. 1996. Yield targeting approach for fertilizer recommendation to wheat on *vertisols* of Maharashtra. *J. Indian Soc. Soil Sci.* 44 (1) 81-84.
- Tegegnetwork GW, Shanwad UK, Desai BK, Koppalakar BG, Shankergoud I 2015. Response of soil test crop response (STCR) as an optimizing plant nutrient supply on yield and quality of sunflower (*Helianthus annuus* L.). *African Journal of Agricultural Research*. 2; 10(28):2680- 2686.
- Tisdale, S. L. 1967. Soil testing and plant analysis. In part I soil testing NO. 2 *Soil Sci. Soc. Amer. Special Publication Series*. 1- 11.

- Troug, E. 1960. Fifty years of soil testing. Transactions of 7th International Congress of Soil Science, Vol. 3, Commission IV, Paper No. 7, 46-53.
- Verma, T. S. Suri, V. K. Sandal, S. K. and Paul, J. 2005. Validation of soil test based Fertilizer adjustment equations on targeted yield in wet temperature zone of Himachal Pradesh. Indian J. Agril. Sci., 75:654-657.
- Yadav, R.L., Dwivedi, B .S., Prasad, K. and Tomar, O.K. 2000. Yield trends and changes in soil organic carbon available MPK in a long term rice wheat system under integrated use of manures and fertilizers. Field Crops Res., 68: 219-246.
- Walkley, A. and Black, C.A. 1934. Estimation of soil organic carbon by chromic acid titration method. Soil Sci., 47: 29-38.

APPENDIX

Weekly meteorological data during the crop growth period (2021)

Wk No.	Date	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)	Relative Humidity (%)		Wind Velocity (Kmph)	Evaporation (mm)	Sun Shine (hours)
					I	II			
40	Oct 01-07	31.8	25	12.8	90	63	2.6	20.5	4
41	08-14	32.5	25.3	0	90	66	4.4	22.4	5
42	15-21	31.9	24.4	7	90	60	5	23.3	6.5
43	22-28	32.6	20.1	0	87	35	2.1	24.1	8
44	29-04	31.8	17.4	0	82	30	2.2	24.9	7.6
45	Nov 05-11	30.3	12.5	0	87	28	2.1	23.5	8.5
46	12-18	32.7	18.9	0	87	37	2.9	24.9	8.5
47	19-25	31	15.9	0.4	88	35	2.8	23.1	7.4
48	26-02	28.6	14.7	0	81	35	4	22.4	6.2
49	Dec 03-09	30.7	11.9	0	89	33	1.3	22.2	7.3
50	10-16	30.2	15.8	0	86	37	2.4	20.1	3.7
51	17-23	27.7	10.3	0	87	27	2.5	22.7	5
52	24-31	28.4	10.3	0	87	28	1.8	24.6	4.8
1	Jan 01-07	29.7	13.8	0	85	32	2.2	20.1	3.2
2	08-14	31.2	16.3	0	78	30	2.4	22.6	3.9
3	15-21	30	11.7	0	83	24	2.6	24	6.1
4	22-28	31	14.2	0	80	36	2.6	24.4	3.3
5	29-04	28.2	10.3	4.6	81	23	2.8	24.1	6.8
6	Feb 05-11	30.1	10.6	0	78	20	2.5	27.5	9.5

7	12-18	31.4	14.9	1	80	41	2.9	25.4	3.6
8	19-25	30.9	14.5	1.4	81	30	2.8	27.2	7.4
9	26-04	35.8	15.7	0	69	16	3.1	42.3	9.5
10	Mar 05-11	36.3	17.3	0	64	21	3.5	43	8.3
11	12-18	34.7	19.4	6.2	76	27	3.3	36.1	5.9
12	19-25	35.1	20.1	1.4	65	28	4.2	35.5	5
13	26-01	39.7	20.6	0	51	13	4.6	56.4	8.3
14	Apr 02-08	40.4	21.4	0	57	18	3.9	56.2	7.4
15	09-15	38.5	23.8	0	53	22	6.2	57	5.7
16	16-22	38.8	23.2	1	55	23	5	48.7	6.7
17	23-29	40.2	22.9	0	48	15	3.9	56.4	8.6
18	30-06	39.9	25.2	0	54	27	6.7	60.5	7.9

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