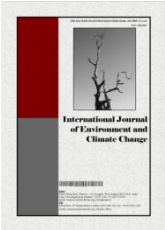

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Effect of Soil Test Crop Response Based Long-Term Fertilization on Yield Attributing Parameters and Yield of Wheat (*Triticum aestivum* L.)

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Authors' contributions

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

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ABSTRACT

A field experiment was carried out during *Rabi* season of 2020–2021 and 2021–2022 at the Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur (Madhya Pradesh) at research field of department of soil science to find out the effect of soil test crop response based long-term fertilization on yield attributing parameters and yield of wheat. The treatments details were T_1; Control, T_2 ; 120 N: 80 P_2O_5: 60 K_2O kg ha^{-1} , T_3; Target yield of 4.5 t ha^{-1}, T_4; Target yield of 6.0 t ha^{-1}, T_5; Target yield of 4.5 t+FYM 5 t ha^{-1}; T_6; Target yield of 6.0 t+FYM 5 t ha^{-1} and carried out in Randomized Block Design (RBD) with four replications. Research findings of long term field experiment revealed that application of soil test crop response recommendation for target yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1} gave maximum earhead length (14.59 and 14.10 cm), number of grains ear^{-1} (66.46 and 63.30), test weight (41.93 and 41.35 g), grain yield (5568 and 5052 kg ha^{-1}) and straw yield (7315 and 5969 kg ha^{-1}) of wheat. The balanced application of fertilizers by the soil and the crop's needs for potential growth and development may account for the increased yield under the STCR technique with and without FYM. The inclusion of FYM resulted in a potential movement of

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water, air, temperature, and nutrients in the soil, which may have improved the conditioning of the rhizospheric environment and further raised yield when integrated with STCR. Due to better physical, chemical, and biological characteristics, enhanced microbial activity and the conversion of inaccessible nutrients into available forms, this STCR technique also aids in higher production.

Keywords: FYM; STCR; target yield; wheat; yield attributing.

1. INTRODUCTION

Globally, a vast population highly depends on wheat (*Triticum aestivum L.*), which provides approximately 20% of people's daily protein and calories [1]. Wheat is the second most important food grain of India with an area of 32 million ha, production of 107.86 million tons, and an average productivity of 3370 kg ha^{-1} [2]. Due to varying meteorological conditions, genotypes, sowing time and techniques, and other management practices, wheat yield varies significantly across India's many agro-ecologies [3]. The wheat crop contributed significantly in food grain production for ensuring nations food security. There are reports of decreasing crop yields which raised questions on sustainability of the wheat crop. The reasons behind is farmers use excessive amounts of chemical fertilizer to increase yield attributes and yields [4] but choosing how much fertilizer to use on which crops depends on understanding how those crops will respond to the nutrient application and predicted output. This approach costs farmers money in addition to harming the soil's health [5] and [6]. Additionally, the negative effects of high-analysis chemical fertilizer use on soil productivity and the environment created an energy problem and a concern with sustainability in agriculture. Environmental contamination is also brought on by the indiscriminate and ongoing use of inorganic fertilizers, Prajapat et al. [7] and Prasad [8] which have been found to have a deleterious impact on the physico-chemical and biological properties of soil [9]. Wheat production can be increased significantly using the soil test crop response (STCR) technique [10] and [11]. In this method, the recommended fertilizer doses are determined using fertilizer adjustment equations that were created after a substantial association was established between the soil test results and the additional fertilizer. Because it incorporates the combined use of soil and plant analysis, which provides details on the actual balance between applied nutrients and the nutrients that are now accessible in the soil, recommendations based on the STCR correlation idea are more quantitative, exact, and relevant [12] and [13]. Alternatively, organic manures (OM) are a rich source of nutrients; their single application is insufficient to cover the nutrient needs of high-producing types and frequently provides subpar crop production [11] and [14]. Due to exhaustion in soil health, employing the generally recommended dose (GRD) of fertilizer is also unable to maintain yields about the economic returns of crops, necessitating refinement for balanced crop nutrition [15]. Therefore, using only organic matter or chemical fertilizer won't help an intensive production system become more sustainable [16]. To provide balanced fertilization to crops, it is a step forward to employ an appropriate blend of organic and chemical fertilizers [17], depending on the soil fertility state [18]. This integrated nutrient management (INM) type can increase yield attributing and yield of wheat [19-21]. According to soil test crop response based research experiment results show a very close correlation between targeted yield and yield actually obtained and evidence of the usefulness of soil testing within the limit of variation under field conditions. Keeping all these point in mind the present investigation was conducted to determine the “Effect of soil test crop response based long-term fertilization on yield attributing parameters and yield of wheat”.

2. MATERIALS AND METHODS

2.1 Experimental Site and Experimentation

Field experiments were conducted during *Rabi* season (December–April) of 2020–2021 and 2021–2022 at the Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV) research field under the ongoing AICRP on Soil Test Crop Response, managed by Department of Soil Science, Jabalpur at 23º13' North latitude, 79º57' East longitudes and at an elevation of 393 m above mean sea level. The treatments details were T_1; Control, T_2 ; 120 N:80 P_2O_5:60 K_2O kg ha^{-1} , T_3; Target yield of 4.5 t ha^{-1}, T_4; Target yield of 6.0 t ha^{-1}, T_5; Target yield of 4.5 t+FYM 5 t ha^{-1}; T_6; Target yield of 6.0 t+FYM 5 t ha^{-1} and carried out in Randomized Block Design (RBD) with four

replications. Nutrients doses (kg ha^{-1}) were calculated from the fertilizer adjustment equations for targeting yields 4.5 and 6.0 t ha^{-1} of wheat. The fertilizer adjustment equations are given below:

$$FN=4.40\ T-0.40\ SN \quad (1)$$

$$FP_2O_5=4.00\ T-5.73\ SP \quad (2)$$

$$FK_2O=2.53\ T-0.16\ SK \quad (3)$$

Whereas,

FN=Fertilizer nitrogen (kg ha^{-1}); FP_2O_5=Fertilizer phosphorus (kg ha^{-1}); FK_2O=Fertilizer potassium (kg ha^{-1}); T=Desired yield target (t ha^{-1}); SN=Available soil nitrogen (kg ha^{-1}); SP=Available soil phosphorus (kg ha^{-1}); SK=Available soil potassium (kg ha^{-1}).

2.2 Data Collection

Wheat growth parameters such as length of ear $head^{-1}$, number of grains per ear head were studied at harvest. Five randomly chosen ear heads from tagged plants were used to measure the length of ear $head^{-1}$ after that threshed manually and number of grains per ear head was counted. For estimating grain and straw yield, wheat crop from a net plot area of 16 m^{-2} was harvested and sun dried. After drying, manual threshing was carried out. Grain weight and straw weight was taken from each treatment and expressed as kg ha^{-1}. 1000 grains were counted manually after threshing of each plot then weighed in electronic balance and expressed in grams.

3. RESULTS AND DISCUSSION

3.1 Effect of Different Treatments on Yield Attributes of Wheat

The data pertaining to the yield attributes and yield of wheat is presented in Table 1. The significantly higher ear head length of 14.59 and 14.10 cm was observed in target yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1} which were at par with target yield of 6.0 t ha^{-1} (12.04 and 11.56 cm) but found statistically significant over rest of the treatments during 2020–21 and 2021–22. The minimum ear head length was recorded under control 6.12 and 5.70 cm during both the year (Fig. 1). Similarly, long term nutrient management of STCR on number of grains revealed that the application of nutrient as GRD, target yield of 4.5 t ha^{-1}, target yield of 6.0 t ha^{-1} target yield of 4.5 t ha^{-1}+FYM 5 t ha^{-1} and target yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1} significantly increased the no. of grains ear^{-1} over control during both the years. However, application of nutrients for target yield of 6.0 t ha^{-1}, target yield of 4.5 t ha^{-1}+FYM 5 t ha^{-1} and target yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1} were found significantly superior to GRD and target yield of 4.5 t ha^{-1} but the treatments were found at par amongst themselves during both the years.

The maximum number of grain ear $head^{-1}$ during the first year (66.46) and second year (63.30) were observed with target yield of 6 t ha^{-1}+FYM 5 t ha^{-1}. This might be due to the supply of the nutrients in a balanced amount and slowly release of nutrients through the integration use of FYM which helped to produce more numbers of grains ear^{-1} and ear head length. The spike length directly showed the higher no of grains in the panicle so that yield will be increased. These results are supported by Moharana et al. [22] Sheoran et al. [23] and Kumar et al. [24]. An examination of data indicated that test weight in (Table 1) target yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1} found maximum which was significantly higher than GRD (120 N: 80 P_2O_5: 60 K_2O kg ha^{-1}) and control but found to be at par with remaining treatment. According to Patel et al. [25], an adequate nutrient supply increases photosynthetic activities. It translocates more photosynthates in the reproductive stages of the crop, thereby promoting growth and increasing wheat's test weight—this increased wheat's test weight when chemical fertilizer, including organic manure, was used. The increased availability of nutrients to plants, first through fertilizers and later through FYM, is attributed to the rise in yield. In addition to supply nutrients, FYM also improves physical conditions of soil. Tiwari et al. [26], Sellamuthu et al. [27], Singh et al. [28] and Rai et al. [29] also noted similar results which support the results of the present experiment.

3.2 Effect of Different Treatments on Grain and Straw Yield of Wheat

The effect of different treatments on the grain and straw yield of wheat has been shown in Table 2. It is evident from the data indicated that the application of STCR based NPK level as GRD, target yield of 4.5 t ha^{-1}, target yield of 6.0 t ha^{-1} target yield of 4.5 t ha^{-1}+FYM 5 t ha^{-1} and target yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1} significantly increased the grain and straw yield of wheat over control during both the years. However,

application of nutrients for a target yield of 6 t ha^{-1}+FYM 5 t ha^{-1}, target yield of 6.0 t ha^{-1} and target yield of 4.5 t ha^{-1}+FYM 5 t ha^{-1} significantly increased the grain and straw yield of wheat over GRD. The application of nutrient for a target yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1} also found significantly superior to target yield of 4.5 t ha^{-1} for grain and straw yield during both years except for straw yield during second year. The maximum grain yield 5568 and 5052 kg ha^{-1} and straw yield 7315 and 5969 kg ha^{-1} were observed with a nutrient application for target yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1} during first year, second year. The balanced application of fertilizers by the soil and the crop's needs for potential growth and development may account for the increased yield under the STCR

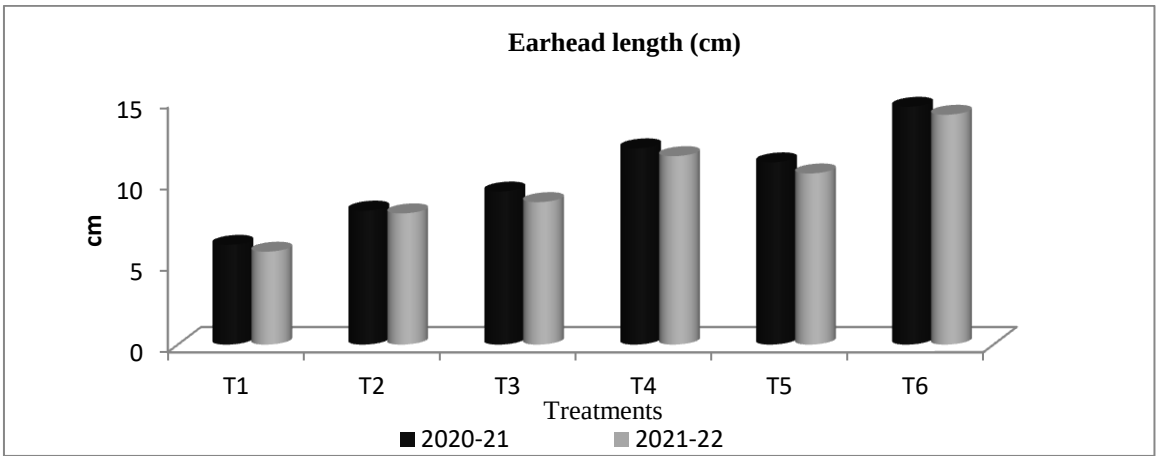

Fig. 1. Effect of long term nutrient management of STCR approach on earhead length

Table 1. Effect of long-term nutrient management of STCR approach on yield attributes in wheat

Treatment	Number of grains ear^{-1}		Test weight (g)	
	2020–21	2021–22	2020–21	2021–22
T_1-Control	38.87^{c}	34.73^{c}	35.12^{c}	34.54^{d}
T_2- GRD (120 N: 80 P_2O_5: 60 K_2O kg ha^{-1})	47.60^{b}	45.95^{b}	38.45^{b}	37.33^{cd}
T_3- Target Yield of 4.5 t ha^{-1}	50.96^{b}	47.80^{b}	39.82^{ab}	38.20^{bc}
T_4- Target Yield of 6.0 t ha^{-1}	62.25^{a}	60.20^{a}	41.38^{ab}	41.08^{ab}
T_5-Target Yield of 4.5 t ha^{-1}+FYM 5 t ha^{-1}	61.61^{a}	58.82^{a}	40.83^{ab}	39.26^{abc}
T_6-Target Yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1}	66.46^{a}	63.30^{a}	41.93^{a}	41.35^{a}
SEm±	2.06	1.78	1.08	1.00
CD (*p*=0.05)	6.22	5.36	3.25	3.03

Different letters, i.e., a, b, c within a column indicate significant difference accordingly to least significant difference (LSD) test (CD p=0.05)

Table 2. Effect of long term nutrient management of STCR approach on yield and straw in wheat

Treatment	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	2020–21	2021–22	2020–21	2021–22
T1- Control	2145^{d}	961^{d}	3017^{d}	1445^{c}
T2- GRD (120 N: 80 P_2O_5: 60 K_2O kg ha^{-1})	4171^{c}	3898^{c}	5495^{c}	4734^{b}
T3- Target Yield of 4.5 t ha^{-1}	4683^{bc}	4219^{bc}	6079^{bc}	5281^{ab}
T4- Target Yield of 6.0 t ha^{-1}	5177^{ab}	4805^{ab}	6731^{ab}	5906^{a}
T5-Target Yield of 4.5 t ha^{-1}+ FYM 5 t ha^{-1}	5095^{ab}	4586^{ab}	6688^{ab}	5883^{a}
T6- Target Yield of 6.0 t ha^{-1}+FYM 5 t ha^{-1}	5568^{a}	5052^{a}	7315^{a}	5969^{a}
SEm±	184.23	198.08	272.10	245.11
CD (*p*=0.05)	555.22	596.96	820.02	738.68

Different letters, i.e., a, b, c within a column indicate significant difference accordingly to least significant difference (LSD) test (CD p=0.05)

technique with and without FYM. The inclusion of FYM resulted in a potential movement of water, air, temperature, and nutrients in the soil, which may have improved the conditioning of the rhizospheric environment and further raised yield when integrated with STCR. Due to better physical, chemical, and biological characteristics, enhanced microbial activity and the conversion of inaccessible nutrients into available forms, this STCR technique also aids in higher production [30]. Wheat's increased yield appeared to be the result of a combination of yield characteristics supported by a balanced supply of nutrients [31,32] and [33]. The results of the present experiment confirmed the finding of Parewa et al. [14] and Moharana et al. [22].

4. CONCLUSION

Results of a long-term experiment concluded that STCR recommendation on wheat brought an additive effect in increasing yield attributes and yield of wheat crop. Application of STCR recommended for target yield 6.0 t ha^{-1}+FYM 5 t ha^{-1} gave maximum yield attributes, grain and straw yields. These study results proved that STCR recommended gave better results of all yield attributing characteristics and yield of wheat in the comparison of the general recommended dose.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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