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Impact of STCR based application of Organic and Inorganic Fertilizers on growth and yield of Wheat (*Triticum aestivum* L.) in an Inceptisol of Central Plain Zone of Prayagraj

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ABSTRACT

A field experiment was conducted for two consecutive years during the Rabi seasons of (Wheat) 2020-21 and 2021-22, at Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, District of Uttar Pradesh. The central objective of this experimentation was to evaluate the implications of employing a Soil Test Crop Response (STCR) strategy for fertilizer application and its pursuant impression on growth and yield within the context of Inceptisol soil order, with a focused emphasis on wheat (Triticum aestivum L.) plowing within the Prayagraj region. Sandy loam in soil texture, belongs to soil order Inceptisol and neutral to saline in soil reaction. Soil quality is one important aspect of sustainable agro-ecosystem management, analogous to water and air quality. Soil samples were taken from two depth viz.0-15 cm and 15-30 cm and analyzed for their physico-chemical properties (Soil texture, BD, PD, Soil pH, EC, OC, Available N, P & K). The experiment was carried out in Randomized Block Design and replicated thrice with 9 treatments. The growth attribute like plant height, number of tillers per plant, number of green leaves per plant and plant dry weight was observed significant at 120 DAS on a pooled basis (Years 2020-21 and 2021-22). The best treatment combination was (T_9) STB (150:15:150 NPK kg ha^{-1}) + FYM 15 t ha^{-1}, which displayed grain yield of 6.49, 6.52 and 6.50 t ha^{-1} on a pooled basis respectively. Traditional unscientific cropping system adopted by large number of farmers in most of the areas. Non - adoption of the recommended dose of the fertilizers and balanced fertilization. Therefore, it is concluded that the reposeful use of NPK fertilizers with FYM- based organic fertilizer on STCR viewpoint not only gave best wheat yield but also elevated soil quality and environment friendly.

Keywords: *Wheat crop, STCR, Soil quality, physico-chemical properties of soil and Yield.*

Introduction

Wheat is the second most important cereal crop in India next to rice in respect of area and production. Uttar Pradesh is the maximum wheat- producing state in India and Punjab has the highest productivity. Wheat is grown in practically all the states in northern and central India. Uttar Pradesh produces about 20.36 million tons of wheat covering the 9.85 million hectare (2014-2015). It grants about 25.91 percent in the national out-turn of wheat 2014-2015 [5].

Developed the methodology of soil test- based nutrient commendation for targeted yield. It is a more quantitative, accurate and meaningful approach because it involves combined use of soil and plant analysis, which bestow_ know-how on real balance between well-becoming feeder and available nutrients of soil [17].

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Soil Test Crop Response (STCR) STCR outlook bestow_ the balanced victuals of expected quantities of dose to the crops thus avert the over and under praxis of fertilizers. This inhibits the environmental riskiness and efficacy in supreme returns. Crop necessity_ is satisfied to out- turn the highest economic yields, decasualize the deal of the produce and avoid excessive scale of nutrients [2]. Soil test crop response (STCR) is a base for prescription of the correct amount of fertilizers to the crops. No single dose of plant nutrient well-becoming through inorganic fertilizer, organic manure, crop residue or bio-fertilizers can conjoin the overall nutrient requirement of a crop in present - day_ inveterate agriculture [7],[20]. The STCR perspective benefits farmers by optimizing fertilizer nutrient praxis and allowing for yield preference based on their economic conditions [1],[11],[12]. _ Currently, the mightiness in utilizing essential nutrients like phosphorus (P), nitrogen (N), sulfur (S), zinc (Zn), iron (Fe), and copper (Cu) is far out from par excellence. This inability has implications for soil fertility and the availability of nutrients for plants. In the 21st century, agriculture faces challenges such as food security, embalming environmental quality, and promoting soil health. India, in particular, scuffles with diminishing land holdings and

escalating input costs, calibrate the urgent need for scientific approaches to nutrient management to cultivate crop productivity [8],[9], [16].

Material and Methods

The study spanned two consecutive years, commencing from the rabi seasons of 2020-2021 and 2021-2022, and was carried out at the Research Farm of the Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology& Sciences, located in the Prayagraj District of the State Uttar Pradesh. The experiment was carried out in Randomized Block Design (RBD) and replicated thrice with 9 treatments. The geographical coordinates place this site to the south of Prayagraj, adjacent to the Yamuna River's right bank, approximately 6 kilometers away from the city center. This position falls within the North Alluvial plain zone (0-1% slope) of the Agro-Ecological Sub Region and is categorized within the Agro-Climatic Zone of the Upper Gangetic Plain Region. The specific coordinates of this research location are approximately 25°24'30" N latitude and 81°51'10" E longitude, with an elevation of approximately 98 meters above sea level. Regarding climatic conditions, the Prayagraj District experiences a subtropical climate characterized by scorching summers and relatively chilly in winters. Summer temperatures can range between 46°C and 50°C, while winter temperatures occasionally dip below 4°C. Relative humidity level ranges from 20 % to 94 %, and the area receives an average annual rainfall of around 1100 mm. Soil samples were procured at the commencement of the experimentation during the rabi seasons of both years 2020-21 and 2021-22. A soil auger was utilized to extract samples from two distinct depths 0 - 15.0 cm and 15.0 - 30.0 cm. The wheat variety PBW-343 was cultivated.

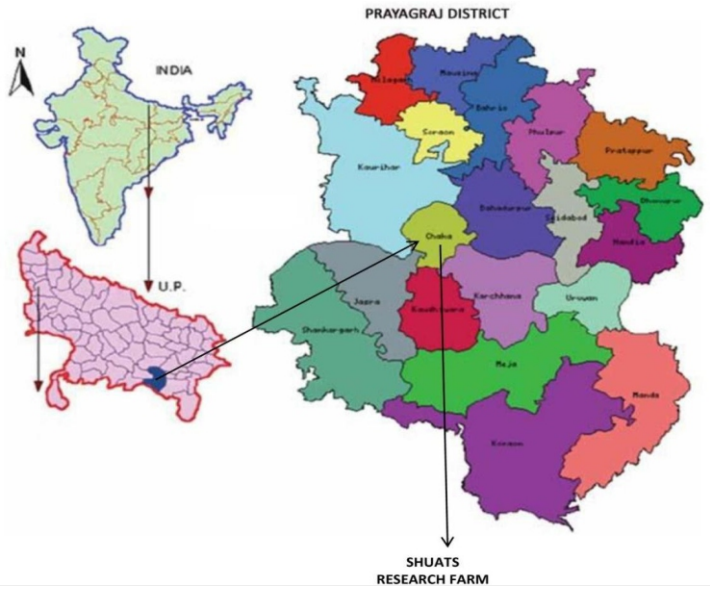

Fig. 1. Geographical Map of Research Area

Soil Characteristics of the Experimental Site

The experimental site was fairly level land with sandy loam soil of uniform fertility status with low clay and high sand percentage. Soil sample were collected at random spots from soil depth of 0-15 and 15-30 cm depth and the soil were analyzed for pH, EC, OC, BD, PD, soil porosity, available nitrogen, available phosphorus and available potassium at the Research Farm of the Department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj (Uttar Pradesh) during years 2020-21 and 2021-22.

Treatment combinations

9 treatment combinations are mentioned as below:

Legend

FP - Farmers practice
GRD - General recommended fertilizer dose
STB - Soil test-based fertilizer dose
FYM - Farm yard manure
T_1 - FP (80:57:0 NPK kg ha^{-1})
T_2 - GRD (120:60:40 NPK kg ha^{-1})
T_3 - GRD+FYM 5 t ha^{-1}
T_4 - GRD+FYM 10 t ha^{-1}
T_5 - GRD+FYM 15 t ha^{-1}
T_6 - STB (150:15:150 NPK kg ha^{-1})
T_7 - STB+FYM 5 t ha^{-1}
T_8 - STB+FYM 10 t ha^{-1}
T_9 - STB+FYM 15 t ha^{-1}

Application of Fertilizers

A basal dose of FYM 5,10 and 15 t ha^{-1}, was applied at the time of preparatory tillage and that fertilizers were applied @ FP (80:57:0 NPK kg ha^{-1}), _GRD (120:60:40 NPK kg ha^{-1}) and STB (150:15:150 NPK kg ha^{-1}).Half of the dose of nitrogen and total doses of phosphorus and potash were applied as basal dressing before sowing and mixed with soil. The first 25% nitrogen was applied as top dressing at 21 DAS (CRI stage), rest 25% nitrogen was supplied at 45 DAS (Tillering stage). The fertilizers were applied in the form of urea, single super phosphate and muriate of potash. The amount of fertilizers required for each plot was weighed separately and broadcasted after irrigation. The total amount of FYM required was 108 kg, the amount of Urea required was 4.33 kg, total amount of SSP required by 3.58 kg and the amount of MOP required 2.27 kg applied in experimental plots (plot size was 3.0 m x 2.0 m).

Statistical analysis and Design

The data recorded during the course of investigation was subjected to statistical analysis by ANOVA technique [6]. The significant and non-significant of treatment effect was judged with the help of F (Variance Ratio) test. The significant difference between the mean were tested against the critical at 5% level. The experiment utilized 3^2 factorial Randomized Block Design (RBD) with three replications. The study involved the application of both types of fertilizers sources i.e., organic fertilizer, such as FYM, as well as inorganic types of fertilizers like Urea, SSP and MOP sources of NPK treatment, making 9 treatment combination, each replicated three times.

Field layout details

Number of treatments nine, plot size was 3.0 m x 2.0 m, gross cultivated area was 250. 75m^2.The wheat variety PBW-343 was used. Using spacing 22.5 cm x 5.0 cm, seed rate 100 kg ha^{-1}. Thiram treating 3 seeds were placed in rows at a depth of 3.0 cm.

Soil analysis

The preliminary and post soil samples were gathered to analyze various soil properties (Physical and Chemical properties). The particle size analysis (Soil texture) was determined Bouyoucos hydrometer method [3], bulk density and particle density was determined by Muthuvel's graduated cylinder method [14]. The soil pH was measured utilizing a glass electrode pH meter (Model-Systronics-36),adhering to a soil-water suspension ratio of 1:2.5, a method recommended by Jackson [10].The electrical conductivity (EC) of the soil was judged using EC bridge (Systronics digital conductivity meter–304.) at a soil to

water ratio of 1:2.5[22].Organic carbon content in the samples was evaluated by assuming Walkley and Black Wet oxidation method [21].Available nitrogen was determined by Modified alkaline permanganate oxidation method [18]. Available phosphorus was determined following the procedure established by Olsen's extraction Spectrophotometric method [15] and Available potassium was determined according to the Flame photometric method [19].

Table: 1 Effect on Soil Physical Properties during 2020-21

Treatments	BD (Mg m^{-3})		PD (Mg m^{-3})		Porosity (%)	
Depth	0-15	15-30	0-15	15-30	0-15	15-30
T_1	1.42	1.44	2.65	2.61	48.81	48.35
T_2	1.39	1.39	2.62	2.61	49.53	49.56
T_3	1.42	1.37	2.63	2.63	48.38	49.78
T_4	1.37	1.31	2.66	2.61	50.11	49.78
T_5	1.38	1.37	2.61	2.64	49.67	48.16
T_6	1.30	1.28	2.63	2.65	50.20	49.85
T_7	1.29	1.32	2.63	2.65	47.95	50.05
T_8	1.27	1.29	2.61	2.63	49.60	48.87
T_9	1.31	1.27	2.64	2.64	49.73	49.83

Table :2 Initial physico-chemical properties of soil during 2020-21 and 2021-22

2020-21		2021-22	
Soil characteristics	Soil depth (0-15 cm)	Soil characteristics	Soil depth (0-15 cm)
Sand	60.75	Sand	60.30
Silt	19.23	Silt	19.25
Clay	20.12	Clay	20.45
Textural class	Sandy loam	Textural class	Sandy loam
Bulk density	1.33	Bulk density	1.32
Particle density	2.65	Particle density	2.63
Porosity	50.50	Porosity	50.45
Soil PH	7.50	Soil PH	7.40
EC	0.29	EC	0.27
O C (%)	0.45	O C (%)	0.51
Available N (kg ha^{-1})	144.31	Available N (kg ha^{-1})	178.23
Available P (kg ha^{-1})	15.72	Available P (kg ha^{-1})	16.54
Available K (kg ha^{-1})	244.19	Available K (kg ha^{-1})	234.13

Table: 3 History of the cropping pattern of experimental field area

Year	Kharif	Rabi
2017-18	Maize	Wheat
2018-19	Rice	Wheat
2019-20	Maize	Chick pea
2020-21	Rice	Wheat (Experimental)
2021-22	Okra	Wheat (Experimental)

Results and Discussion

Studies showed that significant effect was increasing on average maximum plant height in treatment (T_6), bestowing upon the plant's height 106.88 cm followed by T_7 (105.44 cm) at 120 DAS both years of cropping. This observation finds resonance with the prior research conducted by [4]. Where analogous findings were reported. In their study, the application of a specific nutrient, nitrogen (N), was observed to significantly elevate plant height, further establishing a parallelism between the present study's outcomes and the scientific understanding that certain nutrients can exert a discernible influence on plant growth parameters. Interaction among nitrogen, phosphorus, potassium and FYM levels showed an increase in number of green leaves. The zenith of green leaf count in treatment (T_7), scaling an impressive peak of 39.94 leaves per plant followed by T_8 (39.60 leaves per plant), treatment (T_8) reached a peak of 12.66 tillers followed by T_9 (12.55 tillers) at 120 DAS.The finding of [23]. Emphasize the notable of STCR dose with 5-ton FYM ha^{-1} on the effective tillers of the wheat crops, the maximum value of plant dry weight per plant was observed in treatment T_9, reaching 21.43 g while lower plant dry weights were obtained in treatment T_1 ,with values of 19.05g during the pooled years ._Notably, treatment T_7 exhibited a markedly higher grain weight, recording values of 46.83 g respectively followed by T_9 (46.76 g) for both years of cropping as well as in the overall pooled data. Particularly, Treatment (T_9) emerges with a notably higher grain yield, achieving values of 6.49 tha^{-1},6.52 tha^{-1} and 6.50 tha^{-1} for the respective years (2020-21 and 2021-22). Similarly, treatment (T_8) demonstrated consistent grain yields of 6.45 tha^{-1},6.49 tha^{-1} and 6.47 tha^{-1} across both years of cropping as well as when considering pooled data (2020-21 and 2021-22). Highlighted the positive impact of applying fertilizers on the yield of wheat, they pointed out that best grain yield was achieved when applied a specific combination of nutrients: 120:60:60 NPK kgha^{-1} [13]. These findings align with the results of our own study.

Fig.2 Harvesting Stage of Wheat(cv.PBW-343).

Table:4 Following characters observation recorded (2020-21 and 2021-22) in pooled basis.

Character Treatments	Plant height 120 DAS (cm)	No. of green leave per plant 90 DAS	No. of tillers per plant 120 DAS	Plant dry weight (g) 120 DAS	1000 grain weight (g)	Grain yield (t ha^{-1})
T_1	104.27	38.93	11.66	19.05	45.56	5.65
T_2	104.16	39.27	11.71	20.26	46.08	5.95
T_3	104.38	39.66	11.60	20.22	46.65	6.38
T_4	104.10	39.44	11.49	21.03	46.80	6.21
T_5	105.44	39.49	11.60	21.04	46.38	6.16
T_6	106.88	39.44	12.33	21.06	46.69	6.30
T_7	105.72	39.94	12.22	21.15	46.83	6.34
T_8	105.38	39.60	12.66	21.26	46.54	6.47
T_9	105.16	39.71	12.55	21.43	46.76	6.50
F-test	S	S	S	S	S	S
C.D. Value 0.5%	0.68	0.14	0.07	0.08	0.13	0.07
S.Ed.(±)	1.44	0.30	0.15	0.18	0.29	0.15

Conclusion

The experimental findings have clearly indicated that in wheat, _ the integrated use of organic manures like FYM with inorganic fertilizers. Based on a field experiment on the influence of various doses of organic manures and inorganic fertilizers on wheat growth and yield, a conclusion was reached that the treatment T9 , T8 and T7 show better significantly higher plant height, number of tillers per plant, plant dry weight and grain yield were obtained during pooled analysis under the application of soil test-based fertilizer dose (150:15:150 NPK kg ha-1) + FYM 15 t ha-1 followed by the treatment T8 soil test-based fertilizer dose (150:15:150 NPK kg ha-1) + FYM 10 t ha-1 and treatment T7 soil test-based fertilizer dose (150:15:150 NPK kg ha-1) + FYM 5 t ha-1 respectively. While minimum was recorded for treatment T1 Farmers practice (80:57:0). There is need to integrate both organic and inorganic sources of nutrients for improving soil fertility and achieving higher productivity of wheat crops. STCR can play a key role to address the issue.

Authors Contribution

Dr. Brijesh Kumar: Collected and reviewed the literature and prepared the manuscript. Dr. Tarence Thomas: Provided guidance and improved the manuscript. Dr. Kamlesh Kumar, Dr. Vikram Bharati, Dr. Sunil Kumar, Dr. Meera Kumari, Dr. Janamejay Kumar and Dr. Amrendra Kumar have provided valuable suggestions in preparing the manuscript.

Future Scope of the Study

Soil management practices like inclusion of pulses in cropping system, balanced manuring, integrated nutrient management through organic manures, recycling of available crop residues, legumes as green manuring, biofertilizers etc., with inorganic fertilizers could be considered as a key for improving the soil health and sustainability.

Conflict of Interest

The Authors declare no conflict of interests.

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