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Short Communication

Effect of soil test crop response (STCR) on physical properties of soil under long term experiment in an acid *Alfisols*

Deeksha Choudhary* **and S.P. Dixit**

Department of Soil Science

CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, India.

*Corresponding author: deekshachoudhary005@gmail.com

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Abstract

The effect of Soil Test Crop Response (STCR) based fertilizer application on physical properties of soil was evaluated in an acid Alfisols during rabi season (2017-18). The long term field experiment was initiated since *kharif* season, 2007 at Experimental Farm, Department of Soil Science, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The experiment was laid out in randomized block design, consisting of eight treatments, replicated thrice. The results indicated that the STCR based treatment with target 35 q/ha along with application of FYM @ 5 t/ha recorded lowest bulk density (1.22 Mg/m^3) and particle density (2.52 Mg/m^3). The treatment with target yield 25 q/ha along with application of FYM @ 5 t/ha (51.5 per cent) and treatment with target yield 25 q/ha (50.3 per cent) were statistically at par with each other in reference to porosity. The lowest water holding capacity was found in control (48.1 per cent) followed by general recommended dose (49.5 per cent). Target yield 35 q/ha with FYM @ 5 t/ha recorded highest porosity (51.7 per cent) as well as water holding capacity (53.6 per cent). The long term study based on STCR clearly demonstrated that prescription based fertilizer application not only improved the physical properties of soil but also saved the fertilizer without impairing soil health.

Key words: Bulk density, Fertilizer, Particle density, Porosity and Water holding capacity.

Wheat is one of the most important cereal crops of India. It is cultivated over an area of 31.36 m ha with a production of 107.86 mt in the country (Anonymous 2020). In Himachal Pradesh, it is grown over an area of 318.87 thousand ha with a production of 565.74 thousand tonnes (Anonymous 2017). Presently, nutrient mining is a major threat for arable soil as there is wide gap between nutrient addition and nutrient removal. The primary reason for falling curve of production is imbalanced use of fertilizer doses by the farmers without knowing the initial soil fertility status and nutrient requirement. This further causes adverse effect on soil health and crop both in terms of nutrient toxicity and deficiency.

Concept of targeted yield equation for recommending the fertilizer dose based on soil test values help in balanced fertilizer and nutrient application in the soil. Besides taking into consideration the nutrient requirement of the crop, this concept also considers the soil fertility status, which is the prime requirement for growing the specific crop at a specific location. Soil test crop response approach of fertilizer application was first advocated by Trough (1960) which involved both soil and plant analysis in a scientific basis that proved to be a refined and unique technique for most efficient use of fertilizer and soil nutrients. Recommendations based on STCR correlation concept are more quantitative, precise and meaningful because it involves combined use of soil and plant analysis, which provide information on real balance between applied nutrient and available nutrients of soil (Sharma *et al*. 2016). Farm yard manure along with precise application of fertilizer based on soil test value can help in improving physical properties and also enhances resistance and resilience capacity of soil. In India, fertilizers are generally applied to crops on the basis of generalized state level fertilizer recommendations, though the nutrient requirements of crops vary from place to place even for the same crop, as the fertility is highly variable. Fertilization of crops based on generalized recommendation leads to under fertilization or over fertilization, results in deteriorating physical properties (bulk density, particle density, porosity etc.), lower productivity along with environmental pollution (Sarkar *et al*. 2003). Considering the above said facts, the present investigation was carried out to evaluate the effect of soil test crop response (STCR) on physical properties of soil under long term experiment in an acid Alfisols.

This study was undertaken in an ongoing long term experiment on Soil Test Crop Response based fertilizer recommendation started since *kharif* 2007 at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur using maize-wheat cropping sequence. Present investigation was carried out during rabi 2017-18 on wheat crop. Geographically, the experimental place is located in the Palam valley of Kangra district under mid hill wet temperate agro-climatic zone of Himachal Pradesh. Total rainfall received during crop period was 362.1 mm. Maximum and minimum temperature were 16-33.6^{0}C and 3.1-19.5^{0}C. Texture of soil was silty clay loam. Taxonomically, experimental field belongs to order "*Alfisols*" and sub group "*Typic Hapludalf*" (Verma 1979). The experiment was laid out in randomized block design (RBD) with eight treatments [T_1 - control, T_2 – farmers' practice (FP)*, T_3 – general recommended dose (GRD)*, T_4 – soil test based (STB)*, T_5 – target 25 q/ha, T_6 – target 25 q/ha with FYM @ 5 t/ha, T_7 - target 35 q/ha, T_8 - target 35 q/ha with FYM @ 5 t/ha] each replicated thrice. HPW – 236 variety of wheat was used as test crop for the experiment.

The target yield equations developed for wheat crop were used for calculation of N, P_2O_5 and K_2O, considering the target 25 q/ha and 35 q/ha.

* GRD - 120, 60, 30 kg ha^{-1} N, P_2O_5 and K_2O, respectively

*FP - 25 per cent of general recommended dose + 5t/ha FYM on dry weight basis

*STB – 150, 45, 30 N, P_2O_5 and K_2O, respectively

The fertilizer adjustment equations are given below:

FN = 5.27 T - 0.25 SN – 1.06 ON

FP_2O_5 = 4.13 T – 0.38 SP – 0.98 OP

FK_2O = 2.87 T – 0.15 SK – 0.55 OK

*In above equations, FN, FP_2O_5, FK_2O are doses of N, P_2O_5 and K_2O, respectively in kg/ha. T is yield target (q/ha), SN, SP and SK are soil available N, P and K, respectively in kg/ha. ON, OP and OK are N, P and K that were supplied through FYM kg/ha, respectively. Plot-wise representative soil samples (0- 0.15 m depth) were collected from each plot after harvest of crop. Various methods used for soil analysis are given below:

Physical properties	**Method**	**Reference**
Bulk Density	Large weighing bottle	Lutz (1947)
Particle density	Pycnometer	Gupta and Dhakshinamoorthy (1980)
Porosity	Empirical method	Gupta and Dhakshinamoorthy (1980)
Water holding capacity	Keen's box	Piper (1966)

The results obtained are presented below:

Bulk density

The data pertaining to the effect of prescription based fertilizer application on bulk density of soil at wheat harvest (*rabi* 2017-18) have been presented in Table 1. Bulk density of soil differed significantly and varied from 1.22 Mg/m^3 in control to 1.34 Mg/m^3 in treatment target yield of 35 q/ha. Application of fertilizers either alone or in combination with FYM reduced the bulk density of soil significantly over control. Highest drop in bulk density was recorded in treatments where chemical fertilizers were applied along with FYM, indicating the inclusion of organic manure (FYM) offers two way benefits in terms of soil quality and enhancement of soil fertility. The bulk density recorded in treatment target yield of 25 q/ha was found to be statistically at par with farmers' practice and target yield 35 q/ha. The bulk density of soil under treatments general recommended dose and soil test based decreased significantly by 2.3 and 3.9 per cent over control, respectively. This might be due to the increased root biomass production that might have augmented organic matter content of the soil. Application of fertilizers in combination with FYM for target yield 25 and 35 q/ha significantly decreased the bulk density of soil by 3.2 per cent and 3.3 per cent, respectively over the same treatments but without FYM. The higher bulk density in control might be due to low organic matter content in soil that has also been reported by Islam *et al*. (2011) and Moharana *et al*. (2017).

Table 1. Effect of prescription based fertilizer application on bulk density, particle density, porosity and water holding capacity of soil

Treatment	Bulk density	Particle density	Porosity	Water Holding Capacity
	(Mg/m^3)		per cent	
Control	1.34	2.60	48.3	48.1
Farmers' practice	1.25	2.54	51.0	51.5
General recommended dose	1.31	2.57	48.8	49.5
Soil test based	1.29	2.58	50.1	49.7
Target yield 25 q/ha	1.27	2.56	50.3	52.0
Target yield 25 q/ha with FYM @ 5 t/ha	1.23	2.53	51.5	53.2
Target yield 35 q/ha	1.26	2.56	50.8	51.6
Target yield 35 q/ha with FYM @ 5 t/ha	1.22	2.52	51.7	53.6
CD (P=0.05)	0.03	0.02	1.5	2.4

Particle density

In surface soil (0 -0.15 m), particle density ranged from highest value (2.60 Mg/m^3) to lowest value (2.52 Mg/m^3). The particle density of soil in treatment target yield of 35 q/ha with FYM was statistically at par with target yield of 25 q/ha with FYM and farmers' practice. The STCR approach of target 25 q/ha improved the particle density of soil significantly over general recommended dose and soil test based. This might be due to higher organic content of soil, better aggregation and increased root growth and bio pores (Gupta *et al*. 2010). Similarly, application of fertilizers in combination with FYM for targeted yield of 25 q/ha and 35 q/ha significantly decreased the particle density by 1.2 per cent and 1.6 per cent, respectively over the same treatments but without FYM.

Porosity

A perusal of data (Table 1) revealed a significant effect of soil test based fertilizer based application on porosity of soil. Among various treatments, significantly higher porosity was recorded in treatment target yield 35 q/ha with FYM @ 5 t/ha (51.7 per cent). The porosity of soil recorded in treatment target yield of 25 q/ha with FYM was found to be statistically at par with soil test based and target yield 25 q/ha without FYM. Porosity of soil under farmers' practice increased significantly by 5.6 per cent over control. This might be due to the continuous addition of FYM over the years. The application of fertilizers in combination with FYM for targeted yield of 25 q/ha and 35 q/ha significantly increased the porosity by 2.4 and 1.8 per cent over the same treatments but without FYM.

Addition of FYM promotes total porosity of the soil as the microbial decomposition products of organic matter such as polysaccharides and bacterial gums are known to act as soil particle binding agents (Moharana *et al*. 2017). These binding agents may decrease the bulk density of the soil by improving soil aggregation and hence increase the porosity (Choudhary *et al*. 2018).

Water holding capacity

The results of present study revealed that the water holding capacity of soil ranged from 48.1 per cent in control to 53.60 per cent in treatment corresponding to target yield of 35 q/ha with FYM (Table 1). The treatment target yield of 35 q/ha and 25 q/ha without FYM enhanced the water holding capacity of soil by 3.8 and 4.6 per cent, respectively over soil test based. The reason behind this is better root proliferation, which improves binding within the soil particle and formation of micro pores that hold the water more firmly (Das *et al*. 2016). The treatment comprising farmers' practice significantly enhanced the water holding capacity by 7.1 per cent over control. This might be attributed to continuous application of FYM @ 5 t/ha in farmers' practice treated plots. However, the water holding capacity of soil in treatment with target yield of 25 q/ha without FYM was found to be statistically at par with farmers' practice, soil test based and target yield 35 q/ha.

Conclusion

The application of synthetic fertilizer may initially boost production; however, sole chemical fertilization has a negative impact on soil. Target yield 35 q/ha with FYM and 25 q/ha with FYM resulted in better soil physical properties. Therefore, integrated nutrient management aimed at reducing the use of chemicals by taking into account organic sources in conjugation with chemical fertilizer seems to be a viable option for retaining soil health.

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