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Correlation studies of soil properties under STCR approach with yield of maize (*Zea mays* L.) In an acid Alfisol

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Abstract
The present investigation was carried out to study the comparative effectiveness of farm yard manure and vermicompost under prescription based fertilizer application in maize-wheat system in an acid Alfisol at experimental farm of Department of Soil Science, College of Agriculture, CSK HPKV, Palampur. There were nine treatments which were replicated thrice in a randomized block design. The treatments were control, soil test based, farmers' practice, 100% NPK, target yield (non-IPNS), target yield with 2.5t and 5t FYM ha^{-1} target yield with 2.5t and 5t vermicompost ha^{-1}. The target yield for maize and wheat was 40 q and 35 q ha^{-1}, respectively. The soil of experimental farm was silty clay loam in texture, acidic in reaction (pH 5.1), medium in organic carbon (7.8 g kg^{-1}) with 208, 26.8 and 214 kg ha^{-1} of available N, P and K, respectively. All the chemical properties were positively correlated with grain and straw yield of maize.

Keywords: Prescription based fertilizer application, vermicompost, and soil test based

Introduction
Fertilizers are the important among different factors causative towards agricultural production. The benefits of greater than before use of fertilizers in achieving targets of food grain production are well established. However, practicing farming with high yielding crop varieties under present fertilizers constraints due to the ever increasing prices, a feasible proposition would be the adoption of economic and judicious use of fertilizers and management practices so that the higher investment on fertilizers is reaped adequately. Further, chemical fertilizers alone are unable to maintain the long-term soil health and sustain crop productivity as they are unable to supply all the essential nutrients, particularly the trace elements (Subba Rao and Srivastava 1998) [1]. In conventional soil testing soil is being categorized into low, medium and high fertility classes (Verma *et al.* 2007) [2]. These are generalized recommendations and do not taken into account, the actual content of particular nutrient. The lacuna leads to the development of prescription based fertilizer recommendations for a given soil- crop- fertilizer situation (Ramamoorthy *et al.* 1967) [3]. Prescription based fertilizer application leads to improve physical condition of soil, soil health and ultimately yield. There are direct or indirect relationships among the physical, chemical and biological properties with the yield. To study these relationships amongst soil properties with yield this research proposal was carried out.

Material and Methods
In order to achieve the objectives of the investigation a field study was conducted on the maize and wheat for two years i.e. *kharif* 2011 at the Experimental Farm of Department of Soil Science, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalya, Palampur which was a long term experiment initiated during 2008. There were nine treatments which were replicated thrice in a randomized block design. The treatments were control, soil test based, farmers' practice, 100% NPK, target yield (non-IPNS), target yield with 2.5t and 5t FYM ha^{-1} target yield with 2.5t and 5t vermicompost ha^{-1}.

The target yield for maize and wheat was 40 q and 35 q ha^{-1}, respectively. The soil of experimental farm was silty clay loam in texture, acidic in reaction (pH 5.1), medium in organic carbon (7.8 g kg^{-1}) with 208, 26.8 and 214 kg ha^{-1} of available N, P and K, respectively. The micronutrient cations *viz.* Fe, Mn, Zn and Cu were 21.2, 0.83, 0.99 and 16.9 mg kg^{-1}. During the field experimentation, representative soil samples (0-15 and 15-30 cm depth) were collected from each plot before and after harvest of crop. The soil physical, chemical and biological properties were analysed with the standard procedures. The data generated from field and laboratory analysis were subjected to statistical analysis and interpretation of results as described by Gomez and Gomez (1984) [4].

Results and Discussions

Relationship of chemical properties with grain and straw yield after harvest of maize crop

The relations of grain and straw yield were worked out with different chemical properties

Correlation with chemical properties

The data showed correlation coefficients (r) of different chemical properties (0-0.15 m) and (0.15-0.30 m) soil depth with grain and straw yield after harvest of maize 2011. The data revealed that on the surface soil samples were found positively correlated with grain and straw yield. The highest value was found in available phosphorus (r = 0.964) and lowest in soil pH (r = 0.734) under grain yield. In straw yield maximum correlation value was found in available phosphorus (r = 0.975) and minimum in soil organic carbon (r = 0.711). Similarly, on the sub-surface soil samples, all the chemical properties were found positively correlated with grain and straw yield. The highest value was found in available phosphorus (r = 0.972) and lowest in soil organic carbon(r = 0.802) under grain yield. In straw yield, maximum correlation value was found in available nitrogen (r = 0.976) and minimum in soil organic carbon (r = 0.784).

Table 1: Correlation coefficients (r) of different chemical properties (0-0.15 m) and (0.15-0.30 m) soil depth with grain and straw yield after harvest of maize 2011

Sr. No.	Soil property	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
	0-0.15 m		
1	pH	0.734**	0.711**
2	Soil organic carbon	0.808**	0.786**
3	Cation exchange capacity	0.920**	0.910**
4	Available		
	Nitrogen	0.908**	0.913**
	Phosphorus	0.964**	0.975**
	Potassium	0.698**	0.691**
	Sulphur	0.942**	0.932**
5	Exchangeable		
	Calcium	0.921**	0.911**
	Magnesium	0.913**	0.884**
6	DTPA extractable		
	Iron	0.914**	0.896**
	Zinc	0.946**	0.939**
	Copper	0.894**	0.876**
	Manganese	0.940**	0.924**
	0.15-0.30 m		
1	pH	0.834**	0.797**
2	Soil organic carbon	0.802**	0.784**
3	Cation exchange capacity	0.927**	0.927**
4	Available		
	Nitrogen	0.896**	0.898**
	Phosphorus	0.972**	0.976**
	Potassium	0.768**	0.762**
	Sulphur	0.941**	0.932**
5	Exchangeable		
	Calcium	0.929**	0.920**
	Magnesium	0.907**	0.878**
6	DTPA extractable		
	Iron	0.929**	0.916**
	Zinc	0.823**	0.827**
	Copper	0.902**	0.884**
	Manganese	0.926**	0.912**

**significant at 5% level of significance

Correlation with chemical properties

The correlation coefficients (r) of different chemical properties (0-0.15 m) and (0.15-0.30 m) soil depth with grain and straw yield after harvest of maize 2012. The data showed that on the surface soil samples were found positively correlated with grain and straw yield. The highest value was found in manganese (r = 0.958) and lowest in soil available nitrogen (r = 0.781) under grain yield. In straw yield maximum correlation value was found in manganese (r = 0.957) and minimum in soil available nitrogen (r = 0.779). Similarly, on the sub-surface soil samples all the chemical properties were found positively correlated with grain and straw yield. The highest value was found in exchangeable magnesium (r = 0.953) and lowest in soil available nitrogen (r

= 0.765) under grain yield. In straw yield, maximum correlation value was found in exchangeable magnesium (r = 0.952) and minimum in soil available nitrogen (r = 0.763).

Table 2: Correlation coefficients (r) of different chemical properties (0-0.15 m) and (0.15-0.30 m) soil depth with grain and straw yield after harvest of maize 2012

Sr. No.	Soil property	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
	0-0.15 m		
1	pH	0.866**	0.866**
2	Soil organic carbon	0.869**	0.869**
3	Cation exchange capacity	0.939**	0.939**
4	Available		
	Nitrogen	0.781**	0.779**
	Phosphorus	0.918**	0.918**
	Potassium	0.927**	0.926**
	Sulphur	0.933**	0.932**
5	Exchangeable		
	Calcium	0.928**	0.927**
	Magnesium	0.956**	0.955**
6	DTPA extractable		
	Iron	0.917**	0.916**
	Zinc	0.933**	0.932**
	Copper	0.922**	0.921**
	Manganese	0.958**	0.957**
	0.15-0.30 m		
1	pH	0.866**	0.866**
2	Soil organic carbon	0.894**	0.894**
3	Cation exchange capacity	0.937**	0.936**
4	Available		
	Nitrogen	0.765**	0.763**
	Phosphorus	0.918**	0.918**
	Potassium	0.933**	0.933**
	Sulphur	0.942**	0.941**
5	Exchangeable		
	Calcium	0.945**	0.943**
	Magnesium	0.953**	0.952**
6	DTPA extractable		
	Iron	0.927**	0.926**
	Zinc	0.917**	0.916**
	Copper	0.924**	0.924**
	Manganese	0.936**	0.936**

**Significant at 5% level of significance

The integrated use of chemical fertilizers with organic manures *viz.* FYM and vermicompost might have added organic matter in soil that increased grain and straw yield. This might be due to improvement of physical, chemical and microbiological properties of soil that resulted in increased productivity by increasing availability of plant nutrients (Chaudhary and Thakur 2007) [5]. Further, the organic matter might have supplied macro and micro nutrients and resulted as chelating agents for enhancing the availability of nutrients in soil. These results are in conformity with the findings of Sharma *et al.* (2005) [6], Urkurkar *et al.* (2010) [7] and Thakur *et al.* (2011) [8]. The reasons for increased response to FYM and vermicompost are generally ascribed to the beneficial effects of FYM and vermicompost on soil productivity. The organic manures supply nutrients and chelating agents to soil which maintain balanced supply of nutrients to plants (Brady and Weil 2002) [9]. Insoluble nutrients present in soil are solubilised due to fulvic acid and humic acid liberated from the organic materials and become available to plants for their growth. The increased availability of nutrients in addition to good physical conditions is favourable for higher biological activity and could have resulted in better crop growth and higher yields.

Conclusion

- The correlation values were increased with the application of organic and inorganic sources of nutrients.
- The conjoint use of the organic and inorganic sources of nutrients have increased the availability of the nutrients hence increased the yield of maize.

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