DISSERTATION-I REPORT

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TO STUDY SOIL CHARACTERISTICS FEATURES AND AVAILABILITY OF NUTRIENTS UNDER VARIOUS FERTILIZATION STRATEGIES

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<u>SYNOPSIS</u>

To study soil characteristics features and availability of nutrients under various fertilization strategies

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INTRODUCTION

Wheat is a grass widely cultivated for its seed, a cereal grain which is a worldwide staple food. There are many species of wheat which together make up the genus Triticum; the most widely grown is common wheat (*T. aestivum* L.). Botanically, the wheat kernel is a type of fruit called a caryopsis. Wheat is grown on more land area than any other food crop (220.4 million hectares, 2014). World trade in wheat is greater than for all other crops combined. In 2016, world production of wheat was 749 million tones, making it second most-produced cereal crop after maize.Global Demand for wheat is increasing due to the unique visco-elastic and adhesive properties of gluten proteins, which facilitate the production of processed foods, whose consumption is increasing as a result of worldwide industrialization process and the westernization of the diet. Wheat is an important source of carbohydrates. Globally, it is the leading vegetal protein in human food, having a protein content of about 13% which is relatively high compared to the major major cereals, relatively low in protein quality for supplying essential amino acids. When eaten as the whole grain, wheat is a source of multiple nutrients and dietary fiber.

Soil is a "silent partner" of the farmer. Soil is the basis of farming. It delivers water and nutrients to crops, physically supports plants, helps control pests, determines where rainfall goes after it hits the earth, and protects the quality of drinking water, air, and wildlife habitat. There are three soil properties as most important with regard to any plant response -related functions, these are; soil pH (to regulate nutrient availability), texture (to regulate water transmission properties and fixation and release of nutrients) and organic matter (to realize the cascading effect on whole range of soil physical as well chemical properties, including the biological properties), and above all, plant traits as well nutrient efficient and nutrient responsive both.

The global use of fertilizers is highly unbalanced: Over fertilization in North America, Western Europe, China and India causes environmental pollution, while under utilization in Africa, Eurasia and parts of Latin America causes soil mining (National Geographic, 2013). It has been estimated that the over-fertilization with N in China, occurring in the order of11.8 Mt, could potentially double yields if used on the 174million ha of cropland in sub-Saharan Africa (Ju et al., 2009; Twomlow et al., 2010).

In addition, there is often an imbalance in the ratio of nutrients. Soil and plant diagnostic tools, such as mobile spectrometers (Shepherd and Walsh, 2007) and quick assessment kits, should become an integral part of fine-tuning fertilizer recommendation to soil type, and as guide to producers, traders and users, for targeting the most relevant fertilizer types to their regions and production systems. However, while many claims are made about new devices that rapidly measure soil properties ,interpretation may appear cumbersome, as soil properties can be measured in different ways and the relevance of the data is likely to be crop-and environment-specific. This scenario calls for harmonization and standardization of data and methodologies. Also, instant methods for the assessment of nutrient contents of fertilizers are essential to prevent adulteration yet with daunting challenges (Perumal et al., 2014).

Soil properties dictate to a very large degree the responses of crops to nutrient elements. The pH of a soil, for example, can determine the extent to which a nutrient is available to plants (Marschner, 2012). Change in pH induced by a fertilizer treatment could also complicate the situation: The alkaline nature of some urea-micronutrient mixed fertilizers could impede nutrient solubility and, therefore, availability, as observed for Zn amended to urea (Milani et al. 2012). NH4+-based fertilizers would acidify the soil due to proton release, there by affecting P availability. However, N-fertilizers that acidify the rhizosphere would be suitable for alkaline soils where Fe, Zn and Mn availability are limited. Yet, in many production systems, different fertilizers are applied to soil without proper consideration of soil pH, or the effects of the applied fertilizer on soil pH and thus the availability of other nutrients

Currently, emphasis is placed on improving the use efficiency of fertilizers through the 4R Nutrient Stewardship principle use of fertilizer from the right source, at the right rate and at the right time, with the right placement (IPNI, 2014). A range of agronomic practices are pursued to implement the 4R approach, including precision application, deep placement, row application, coating of fertilizers for slow release to reduce nutrient losses and tuning the timing and availability of nutrients to plant (Chien et al. 2009; Linquist et al. 2013). Unfortunately, the overall progress achieved through these practices has been insufficient to address the flaws of current fertilizers. Yet, fertilizer research has largely been neglected for several decades.

Balanced application of appropriate fertilizers is a major component of INM. Fertilizers need to be applied at the level required for optimal crop growth based on crop requirements and agroclimatic considerations. At the same time, negative externalities should be minimized. Over application of fertilizers, while inexpensive for some farmers in developed countries, induces neither substantially greater crop nutrient uptake nor significantly higher yields (Smaling and Braun, 1996). Rather, excessive nutrient applications are economically wasteful and can damage the environment.

Considering above points present study is planned to fulfill following objectives:

- To study the effect of different forms of fertilizers on growth and morphological parameters of wheat.
- To examine the effect of various forms of fertilizers on yield and yield attributes of wheat.
- To study various fertilizers on zinc and iron availability and quality of wheat grain.

REVIEW OF LITERATURE

Triticum aestivum L. is monocot belongs to kingdom- Plantae, class-Angiosperms, order-Poales, family-Poaceae, Genues-Triticum. Wheat is a grass widely cultivated for its seed, a cereal grain which is a worldwide staple food. Wheat normally needs between 110 and 130 days between sowing and harvest, depending upon climate, seed type, and soil conditions. In particular, spring fertilizer, herbicides, fungicides is applied upon specific stages. Incredible accomplishments have been achieved in agricultural production in China, but many demanding challenges for ensuring food security and environmental sustainability remain. Field Experiments were conducted from 2011-2013 at three different sites, including Honghu, Shayang, and Jingzhou in China, to determine the effects of fertilization on enhancing crop productivity and indigenous nutrient-supplying capacity (INUS) in a rice (*Oryza sativa* L.)-rape seed (*Brassica napus* L.) rotation. Four minerals fertilizer treatments (NPK, NP, NK, and PK)were applied in a randomized complete block design with three replicates. Crop yields were increased by 19-41% (rice) and 61-76% (rapeseed) during the two years of rice-rapeseed rotation under NPK fertilization compared to PK fertilization across the study sites. Yield responses to fertilization were ranked NPK>NP>NK>PK (Yousaf, 2017).

A field experiment was conducted at Indore, from 2000 to 2002 in a vertisol having clay loam texture. The objective was to evaluate the effect of nitrogen-fixing bacteria, phosphorus-solubilising bacteria, vesicular arbuscular mycorrhizae (VAM), and chemical fertilizers on yield performance and quality parameters of Durum wheat (*T. turgidum var.* durum). The grain(5664 kg ha-1)and straw yields were higher under recommended fertilizer dose(100%NPK)than under 50%NPK(4674 kg ha-1).compared to the 50%NPK ,biofertilizers+50%NPK increased grain yield marginally (2-6%) and could not reach the level of significance. However, straw yields were higher under the latter treatments. Protein and beta-carotene contents were higher and the hectolitre weight was lower with 100% NPK as compared to 50%NPK. A drastic reduction in yellow berry content and sedimentation value was noted with the increasing fertility level. These quality parameters did not differ under biofertilizers+50%NPK compared with the 50%NPK. Highest net returns were accrued from 100%NPK. Yield, quality parameters and net returns were the lowest under the unfertilized control (Behera, 2010).

Chemical composition of soil organic carbon (SOC) is central to soil fertility. They hypothesize that change in SOC content resulting from various long-term fertilization strategies accompanies the shift in SOC chemical structure. This study examined the effect of fertilisation strategies along with the time of fertilizer application on the SOC composition by 13c nuclear magnetic resonance (NMR) spectroscopy. The soils subjected to seven fertilizers treatments were collected in 1989, 1999 and 2009, representing 0, 10 and 20 years of fertilization, respectively. The seven fertilizer treatments were (1-3) balanced fertilization with application of nitrogen(N), phosphorus(P) and potassium(K) including organic compost (OM), half organic compost plus half chemical fertilizer (1/2OM) and pure chemical NPK fertilizer (NPK); 4-6) unbalanced chemical fertilization without application of one of the major elements including NP fertilizer (NP), PK fertilizer (PK), and NK fertilizer (NK); and (7) an un amended control (CK). The SOC content in the balanced fertilization treatments were 2.3-52.6% and 9.4-64.6%higher than in unbalanced fertilization/CK treatments in 1999 and 2009, respectively, indicating significant differences in SOC content with the time of fertilizer application between the two treatment groups. There was a significantly greater proportion of O-alkyl C and the lower proportion of aromatic C in balanced fertilization than in unbalanced fertilization/CK treatments in 1999, but not in 2009, because their proportions in the former treatments approached the latter in 2009.principal component analysis further showed that C functional groups from various fertilization strategies tended to become compositionally similar with time. The results suggest that a shift in SOC chemical composition may be firstly dominated by fertilization strategies, followed by fertilization duration (Li et al., 2015).

A soil's potential for producing crops is largely determined by the environment that the soil provides for root growth. Roots need air, water, nutrients, and adequate space in which to develop. Soil attributes, such as the capacity to store water, acidity, depth, and density determine how well roots develop. Changes in these soil attributes directly affect the health of the plant. For example, bulk density, a measure of the compactness of a soil, affects agricultural productivity. When the bulk density of soil increases to a critical level, it becomes more difficult for roots to penetrate the soil, thereby impeding root growth. When bulk density has increased beyond the critical level, the soil becomes so dense that roots cannot penetrate the soil and root growth is prevented. Heavy farm equipment, erosion, and the loss of soil organic matter can lead to increases in bulk density. These changes in soil quality affect the health and productivity of the plant, and can lead to lower yields and/or higher costs of production. Source: NRC 1993.The capacity of soils to be productive depends on more than just plant nutrients. The physical, biological, and chemical characteristics of a soil-for example its organic matter content, acidity, texture, depth, and water-retention capacity-all influence fertility. Because these attributes differ among soils, soils differ in their quality. Some soils, because of their texture or depth, for example, are inherently productive because they can store and make available large amounts of water and nutrients to plants. Conversely, other soils have such poor nutrient and organic matter content that they are virtually infertile.

Organic matter content is important for the proper management of soil fertility. Organic matter in soil helps plants grow by improving water-holding capacity and drought-resistance. Moreover, organic matter permits better aeration. The absorption and release of nutrients, and makes the soil less susceptible to leaching and erosion (Sekhon and Meelu, 1994; Reijntjes, Haverkort and Waters-Bayer, 1992). Concern has also grown in recent years that the use of fertilizers, particularly inorganic fertilizers, can lead to serious environmental consequences. Environmental contamination of this type, however, is largely a problem in the developed world and a few regions of the developing world. As fertilizers make up a small share of the total production costs in many developed countries, farmers often apply fertilizer in excess of recommended levels in order to ensure high yields. Over application of inorganic and organic fertilizers is estimated to have boosted nutrient capacity in the soil by about 2,000 kilograms of nitrogen, 700 kilograms of phosphorus, and 1,000 kilograms of potassium per hectare of arable land in Europe and North America during the past 30 years (World Bank, 1996). Such oversupply of nutrients can lead to environmental contamination, which often has negative consequences for humans and animals.

An experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, (Mymen singh,2012) to evaluate the effect of integrated use of manures and fertilizers on the growth, yield and nutrient uptake by wheat. There were six treatments such as T0 (Control), T1 [STB-CF(HYG)], T2 [CD + STB-CF (HYG)], T3 [PM + STB-CF (HYG)], T4 [COM + STB-CF (COM)] and T5 [FP (Farmers' practice)]. The experiment was laid out in a Randomized Complete Block Design with four replications. The integrated use of manures and fertilizers significantly influenced the yield attributes as well as grain and straw yields of wheat. The treatment T1 [STB-CF (HYG)] produced the tallest plant of 90.17 cm which was identical with T3 [PM +STB-CF (HYG)] and the lowest value was found in control. The 1000-grain weight followed the similar pattern but the tillers hill-1, spike length and spikelets spike-1 did not follow any definite trend. The treatment T3 [PM + STB-CF (HYG)] produced the highest grain yield of 4362 kg ha^{-1} (90.4% increase over control) and straw yield of 5492 kg ha^{-1} (84.79% increase over control). The lowest grain yield (2291 kg ha^{-1}) and straw yield (2972 kg ha^{-1}) were found in T0 (Control). The NPKS uptake by wheat was markedly influenced by combined use of manures and fertilizers and the treatment T3 demonstrated superior performance to other treatments. So the treatment T3 comprising poultry manure in combination with chemical fertilizers on IPNS basis was found to be the best combination of manures and fertilizers for obtaining the maximum yield and quality of wheat at BAU farm (Islam et al., 2014).

Grain yield

The grain yield of wheat varied significantly due to the integrated use of cowdung, compost, poultry manures and NPKS fertilizers. The highest grain yield (4362 kg ha^{-1}) was observed in T3 [PM+ STB-CF (HYG)] and the lowest value (2291 kg ha^{-1}) was recorded in T0 (control).The grain yield produced by T1 [STB-CF (HYG)] was statistically similar with T2 [CD + STB-CF (HYG)], T3,T4 [COM + STB-CF (HYG)] and T5 [FP (Farmers' practice)] although there was a numerical variation in grain yield among the treatments. Based on grain yield, the treatments may be ranked in order of T3 T1T2 T4 T5 T0. With same recommended fertilizer doses poultry manure treated plots gave higher grain 76 Manures and fertilizers influence wheat yield yield than cowdung and compost treated plots. This might be due to the presence of uric acids in poultry manure that hastens the release of nutrients from poultry manure than compost and cow dung. The increase in grain yield over control ranged from 74.38 to 90.40% where the highest increase was obtained in T3 and the lowest one was obtained in T5. Yakub et al (2010) found 6% increase of grain yield by applying urea-N and manures. Haque *et al*. (2001), Asit *et al* (2007) and Bodruzzaman *et al*. (2010) also found increased grain yield with the application of manures and fertilizers in an integrated way.

Straw yield

The straw yield of wheat also responded significantly due to combined use of manures and fertilizers).The maximum straw yield of 5492 kg ha^{-1} was found in T3 [PM + STB - CF (HYG)] and the minimum value of 2972 kg ha^{-1} was noted in T0 (control). The treatment may be ranked in the order of T3>T2>T4 >T1 > T5 > T0 in terms of straw yield. Regarding the percent increase of straw yield, the highest increase (84.79%) was noted in T3 and the lowest increase (47.22%) was observed in T5 FP [farmers' practices]. Akhtar *et al.* (2011) also observed that combined application of organic manure and fertilizers significantly increased the straw yield of wheat.

Two field experiments were conducted at El-Hag Ali region at west Siwa, Siwa Oasis, Matrouh governorate, during 2011/2012 and 2012/2013 growing seasons. The objective of this study was to investigate the effect of mineral, organic, and bio-fertilizer on yield and yield components of bread wheat to improve wheat productivity and minimizing pollution. The study included three levels of organic fertilizer (10, 15, 20 m^3/fed of organic manure), two regimes of bio-fertilizer. (without bio-fertilizer and bio-fertilized with Microbein as Pseudomonas sp., Azotobacter sp., Azospiirillum sp., and B.megaterium), and two levels of mineral fertilizer(100% and 50% of recommended NPK fertilization levels) .Grain yield and its components i.e. plant height, number of tillers/m2, number of spikes/m2, number of spikelets /spike, number of grains/ spike, 1000 grain weight, straw and grain yields were significantly increased by adding bio-fertilizer compared to control in both seasons, respectively. The adding of mineral fertilizer at the rate 100 % of recommended dose of NPK mineral fertilizer and 20 m^3 /fed organic manure fertilizer resulted in significant increment in grain yield, plant height (cm), 1000 grain weight (g), number of spikes/m^2, number of tillers/m^2, number of spikelets/spike, and straw yield compared with rate 50% of recommended dose of NPK mineral fertilizer and the other two levels of organic fertilizer in both seasons. The second order interaction between mineral, organic, and bio-fertilizer was significant for all characters under study in the first and second seasons, respectively. The highest grain yield was obtained by using rate 100% NPK mineral fertilizer, 20 m^3/fed organic manure with adding bio-fertilizer in the first and second season, respectively (Attia et al., 2016).

Sustainable crop management relies on the combined use of organic and inorganic sources of nutrients. The experiment was laid out in a split plot design with manures (control, farmyard manure, sesbania and cluster bean) as main split and mineral fertilizer rates (control, 40-30, 60-45, 80-60, 90-70 and 120-90 kg N-P_2O_5 ha^{-1}) as sub-split. The manures significantly influenced shoot dry weight, N, P and K uptake and soil properties. Conversely, the rates of mineral fertilizers did not have any effect on soil properties, however, significantly enhanced the shoot dry weight and N, P and K uptake. The combined use of manures and mineral fertilizers had a significant effect on shoot P uptake.Farmyard manure was the best manure amendment with 13% reduction in bulk density and 51% increase in organic matter content over control.

Incorporation of farmyard manure increased the shoot dry weight and N, P and K uptake, respectively by 8, 14, 11 and 8% over control. Among rates of mineral fertilizers, recommended rate of mineral fertilizer (120-90 kg N- P_2O_5 ha^{-1}) was the best treatment with corresponding increase of 26, 81, 56 and 55% in shoot dry weight, N, P and K uptake over control. Integration of farmyard manure with recommended rate of mineral fertilizer enhanced shoot P uptake by 17% as compared to solo application of mineral fertilizers. Through this study, it was concluded that farmyard manure at 6 tons ha^{-1} coupled with mineral fertilizer rate of 120-90 kg N- P_2O_5 ha^{-1} was the best source for sustainable soil health and wheat production (Phullan et al., 2017).

Soil Properties

Application of organic manures produced variable effects on soil properties. S Application of organic manures reduced the bulk density of soil. Plots fertilized with farmyard manure reduced bulk density by 13%, compared to the plots fertilized with mineral fertilizers. Both green manure crops i.e. sesbania and cluster bean produced almost equal effects on soil bulk density and reduced it by 5% over mineral fertilizer. Rates of mineral fertilizers alone and in combination with organic manures did not have any significant effect on soil bulk density. Organic matter content of soil increased significantly with the application of farmyard manure and cluster bean. Incorporation of farmyard manure and plowing of sesbania enhanced the soil organic matter content, respectively by 51 and 31% over control. The data presented in revealed that application of organic manures (farmyard manure, sesbania and cluster bean) and rates of mineral fertilizers could not significantly influence the soil pH and porosity (Phullan et al., 2017).

The soils of Dera Ismail Khan (AZ-RC-PARC) are calcareous in nature with low organic matter. The area also falls in hot arid environment where organic amendments and efficient water used to reduce the input cost and improve crop yield. A field experiment was conducted at Arid Zone Research Centre (AZRC), D. I. Khan during year 2014-15 and 2015-16 to investigate the water use efficiency and response of winter wheat (*Triticum aestivum* L.) crop to organic and inorganic fertilizers on a heavy textured soil. The treatments used in the experiment include compost @5 t ha^{-1}, cattle manure @ 5 t ha^{-1}, compost + cattle manure each @ 2.5 t ha^{-1}, NPK @ 150:120: 90 and control (without amendments), replicated four times. The results revealed that organic and inorganic amendments, irrespective of their kind and combinations, exerted significant ($p \leq 0.05$) variation in plant growth, yield parameters of wheat and water use efficiency. The inorganic fertilizer gave significantly higher total dry matter, grain and straw yield and also due to the greater grain yield the water use efficiency calculated was greater in the NPK treatment. Bulk density, porosity and organic matter were significantly improved by the cattle manure and compost treatments. The moisture content and water holding capacity revealed non-significant effect of the treatments. It may be concluded from the current research that water use efficiency in term of grain yield was higher in the treatment plots receiving mineral fertilizer but compost and manures were comparable and showed significant improvement in the soil properties (Subhan et al., 2017)

The experiment was laid out in order to study on effect of organic fertilizer and P fertilizer on yield and yield components of common wheat (*Triticum aestivum* L.) cv. Chemranin Islamic Azad University, Khorramabad branch, Iran in 2015. The experiment was laid out in a split-plot design based on randomized block design with three replications. Treatments were organic fertilizer (0, 10, 20 ton/ha manure and 10, 20 ton/ha compost) in main plots and phosphate fertilizer (0, 50, 75 and 100 percent based on proposed soil analyzing) in sub plot. Analysis of variance results showed that effect of organic and chemical fertilizers and interaction effect of them were significant on some yield components of common wheat. Based on the results, combined application of organic manure or vermicompost with chemical fertilizer has a better effect on yield and yield components of common wheat rather than single application of them and control treatments.

Higher grain yield was obtained in 20ton/ha organic matter and 75% phosphate fertilizer recommendation treatment with the average of 5472 kg/ha as compared with control treatment (without consuming organic matter and phosphate about 3 ton/ha). Therefore, we can conclude that combined application of organic and chemical fertilizers had more efficiency because of some positive interaction between their microorganisms in soil that result to synergistic effect and laid to increase in yield components and in final grain yield. In final our results indicated that higher grain yield observed in combined application 20ton/ha organic matter and 75% chemical P fertilizer and application of combined fertilizer is better for farmer in wheat field of Khorramabad region for high yield and economic benefits in common wheat (Cheraghi et al.,2016).

Materials and methods

(A). Name of experiment: To evaluate the effect of organic fertilizer on biofortification of wheat grain with zinc and iron.

(B). Location: The experiment will be conducted on Agricultural Research Farm, LPU, Phagwara.

(C). Experimental Details:

1. Year of experimentation : 2017-18
2. No. of factors : 3
   a. Varieties
   b. NPK
   c. Organic
3. No. of Varieties : 4
4. No. of treatments : 4
5. No. of replication : 3
6. Total no. of pots : 48
7. Experimental design : Factorial completely randomized design
8. Crop : Wheat

(D). Collection of soil samples: Soil samples will be taken before crop sowing to check the soil pH, organic carbon, electric conductivity, N, P, K and Zn ratio present in soil.

(E). Observations: Observations will be recorded in relation to-

1. Morphological Parameters
2. Biochemical parameters
3. Yield and yield attributes

(F). Analysis: Soil analysis

Initial soil: Initial soil samples will be analyzed for pH, EC, Organic C, available N, P and K and zinc and iron amount present in the soil.

Analytical methods to be followed during investigation are as under

S. N.	Test parameter	Method	References
1	pH (1:2.5)	Glass electrode	Sparks (1996)
2	EC (1:2.5)	Conductivity meter	Sparks (1996)
3	Organic C	Wet digestion	Walkley and Black (1934)

4	Available N	Alkaline potassium permanganate method	Subbiah & Asija (1956)
5	Available P	Olsen's Method	Olsen *et al*. (1954)
6	Available K	Flame photometer	Jackson (1973)
7	Zinc	*Atomic Absorption Spectroscopy*	Walsh (1955)

(G). Study will be conducted in the following manner

- Morphological characters at different stages of crop
- Biochemical parameters at different stages as well as after harvesting
- Measurement of yield and yield related parameters

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