Soil Quality Status of Different Villages in Narayanpur Block of Mirzapur District, Uttar Pradesh

काशी हिन्दू विश्वविद्यालय BANARAS HINDU UNIVERSITY

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THESIS SUBMITTED IN PARTIAL FULFILMENT OF
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in
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Supervisor
Dr. Y. V. Singh

Submitted By
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To,
The Registrar
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Dear Sir,

I have great pleasure in forwarding the thesis entitled **"Soil quality status of different villages in Narayanpur block of Mirzapur district, Uttar Pradesh"** submitted by **Avnish Kumar Singh (ID. No. SWC-15314)** in partial fulfillment of the requirements for the award of the degree of **Master of Science (Agriculture) in Soil Science – Soil & Water Conservation,** Institute of Agricultural Sciences, Banaras Hindu University.

I certified that the entire scheme of investigation reported herein, was planned and carried out by the candidate under my guidance. To the best of my knowledge and belief, the data presented in the thesis are genuine and original. No part of the work has been submitted for any degree or distinction.

Forwarded	**Forwarded**	**yours faithfully**
Head	***Course Co-ordinator***	**(Y. V. Singh)** ***Supervisor***

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Place: Varanasi **Avnish Kumar Singh**

CONTENTS

ABBREVIATIONS

%	-	Per cent
Agri.	-	Agriculture
cm.	-	Centimeter
Cmol $(P^+)kg^{-1}$	-	Centimol per kilogram
Dept.	-	Department
dSm^{-1}	-	Desi simen per meter
EC	-	Electrical conductivity
et al.	-	*Et alia,* and others
Fig.	-	Figure
g kg^{-1}	-	Gram per kilogram
ha.	-	Hectare
i.e.	-	*Id est,* that is
J	-	Journal
K	-	Potassium
kg ha^{-1}	-	Kilogram per hectare
Max.	-	Maximum
mg kg^{-1}	-	Milligram per kilogram
Mha	-	Million hectare
Min.	-	Minimum
mm.	-	Millimeter
N	-	Nitrogen
NIV	-	Nutrient index value
No.	-	number (s)
O.C	-	Organic carbon
^oC	-	degree celcious
P	-	Phosphorus
pH	-	Puissance de hydrogen
S	-	Sulpur
S.N	-	Serial number
Sci.	-	Science
Soc.	-	Society
sq. km	-	Square kilometer
Temp.	-	Temperature
Univ.	-	University
viz.,	-	Vide licet, namely

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Chapter-I

INTRODUCTION

Efficient management of soil and water is the key to sustained food security and live hood of mankind. This is particularly true in Indian context, where damage to soil fertility and depletion and degradation of ground water quality have emerged as major threats to the sustainability of diverse agriculture production systems. Adoption of intensive agriculture practices with less regard to the carrying capacity of soil and water resources, sometimes due to ignorance but mostly due to greed, can be attributed as one of the major reason behind the recent trends in declining factor productivity and decelerating productivity growth rates of important food and non-food crops. Unbalanced and inadequate nutrient used triggered primarily by the incriminate use of certain nutrients and total neglect of others have lead to deterioration of soil health and environmental quality, sub optimal production low input use efficiency and less profit out of the investment in costly agri-inputs e.g. fertilizers. The effect of unbalanced use of nutrients has pushed the fertility depletion to the extent that it has become most threatening to sustainable development of agriculture.

Much of the current concern with regards to environment quality is focused on water and soil because of its importance in maintaining the human health and health of the ecosystem. The quality of water and soil in any ecosystem provides valuable information about the available resources for supporting life in that ecosystem. The quality of water and soil depends as a large number of physico-chemical parameters and analysis. The impact of water pollution and soil pollution on the human being has recently become a favorite subject for investigation in the world. The industrialization and development in agriculture are necessary to meet the basic requirement of people; at the same time it is necessary to preserve the environment. The Village effluent waste waters are loaded with pollutant, along with other chemicals used during agriculture are also responsible for water and soil pollution.

Soil is comprised of minerals, soil organic matter (SOM), water, and air. The composition and proportion of these components greatly influence soil physical properties like including structure, and porosity. These properties influence air and water movements in soil, and thus the ability of soil to function. The organic fraction of a soil, although represents much less than 10% of the soil mass by weight, has a great effect on soil chemical and physical properties. Soil organic matter comprises of carbon, oxygen, hydrogen, nitrogen and smaller quantities of sulphur and other elements. Soil quality can be determined by quantifying the physical, chemical parameters that has a major impact on agricultural productivity and sustainability. Soil is a mixture of mineral and organic constituents that are in solid, gaseous and aqueous states (Voroney *et al*., 2006).

Soil is a natural body consisting of layers (soil horizons) of mineral constituents of variable thicknesses, which differ from the parent materials in their morphological, physical, chemical, and mineralogical characteristics (Birkeland and Peter, 1999). It's composed of particles of broken rock that have been altered by chemical and environmental processes that include weathering and erosion. Soil differs from its parent rock due to interactions between the lithosphere, hydrosphere, atmosphere, and the biosphere (Chesworth, 2008). In an aquatic ecosystem, soil is one of the most important part and ecological factor. The productivity of water body related with soil conditions. Soil serves as a more reliable index for productivity than water qualities.

The ability of soil to provide various nutrients for biological production are assessed through the analysis of important soil constituents such as pH, specific-conductivity, total alkalinity, calcium, magnesium, chloride, nitrate-nitrogen, phosphate phosphorus, sulphate, sodium and potassium. Most of the dying out component of our environment is being contaminated by human activities like rapidly urbanization, industrialization population explosion, agricultural waste and anthropogenic activity.

Soil is an important component of terrestrial ecosystem because it preserves nutrient reserves, supports many biological process (such as activities linked to nutrient cycles) and filters, keeps and transforms pollutants reducing their toxic effect. Soil quality may be affected by land use type and agriculture management practices because these may cause alteration in land productivity Soil quality is a complex and multifaceted concept defined as "the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, to maintain environmental quality and promote plants and animal health".

Nutrients availability depends highly on soil pH. At low pH some metallic elements like zinc and aluminum are overly abundant and highly mobile causing metal toxicity while reducing the availability of elements like calcium and phosphorus which may react to form precipitants. Adversely, at high pH elements such as magnesium and calcium tend to be abundant in the soil solution. Soil quality encompasses many properties and processes as the structural stability of the aggregates water retention capacity of soils and capability of nutrient cycling.

Soil quality is as combination of physical, chemical and biological properties that are able to readily change in response to variations in soil conditions. Agronomic practices designed to optimize production in agriculture, including the inter conversion of forest and agricultural land, strongly affect soil quality long term researches have shown that cultivation of native soil in additions to climatic factors decreases the soil organic matter content. Soil testing is considered an important tool to assess plant nutrient needs and is also a very use full strategy to formulate crop and site specific nutrient recommendations. Soil- test based nutrient used optimizes economic returns and minimizes risk of environmental pollution, compared with adhoc applications.

Water is the one of the essential source of life on earth. It also performs unique and indispensable activities in earth ecosystem, biosphere and biogeochemical cycles. Thus, high quality water is always a necessity for living organisms. Water is the most important component among the natural resources, and is crucial for the existing of all living organisms. Water is a resource that has many uses, including recreation, transportation, and hydroelectric power, domestic, industrial, and commercial uses. Water covers 70.9% of the Earth's surface ("CIA-The world fact book". Central Intelligence Agency), and is vital for all known forms of life ("United Nations". Un.Org. 2005-03-22).

On Earth, water is found mostly in oceans and other large water bodies, with 1.6% of water below ground in aquifers and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation (Water Vapor in the Climate System, Special Report, [AGU], December 1995). Water is also present in the atmosphere in solid, liquid, and vapor states. It also exists as groundwater in aquifers.

Numerous studies have been made to examine the soil quality of agricultural soil in India, but relatively very little work has been done on the soil of Uttar Pradesh. In view of limited available information of the soil quality of Narayanpur block of Mirzapur district, an investigation was therefore undertaken **“Soil quality status of different villages in Narayanpur block of Mirzapur district, Uttar Pradesh”** with following objectives:-

- To study the soil quality status of different villages in Narayanpur block of Mirzapur district, Uttar Pradesh.
- To study correlation matrix between physico-chemical properties of soil of different villages in Narayanpur block of Mirzapur district, Uttar Pradesh.

Chapter-II

REVIEW OF LITERATURE

In this chapter, an attempt has been made to bring together the available information on different aspect of the present investigation entitled **"Soil quality status of different villages in Narayanpur block of Mirzapur district, Uttar Pradesh".** Based on the available information, the literatures reviewed under the following headings.

2.1 Physical properties of soils

- Bulk density
- Particle density

2.2 Chemical Properties of soils

- Soil reaction (pH)
- Electrical conductivity (EC)
- Organic carbon

2.3 Status of available Macro-nutrient

- Nitrogen
- Phosphorus
- Potassium
- Sulphur

2.1 Physical Properties of Soil

The soils of the Vindhyan region differ significantly from each in its physico-chemical properties as reported by **Singh and Kashyap (2006)**. The savanna site had significantly higher pH (7.2), bulk density (1.37 g cm^{-3}) and silt content (67.80%) but lower water holding capacity (1.37%), total-C (16 356 micro g g^{-1} dry soil), N (1090 micro gg^{-1} dry soil) and P (213 micro g^{-1} dry soil) than forest site.

Varadaraju *et al.* (2010) were collected soil samples from different locations along Dakshina Kannada district of Karnataka and selected physico-chemical parameters were analyzed. The values of soil parameters recorded were: water holding capacity: 28.2 to 59.80%, bulk density: 2.03-2.27, pH: 4.46-6.77, salinity: 0-2.95 ppt, organic matter: 1.53-5.95% and permeability: 3.16 x 10^{-5}-2.28x10^{-7} cm sec^{-1}. Textural class of the soil varied from sandy loam to sandy soil. Correlation analysis showed that the water holding capacity of the soil increased with the increase of silt, clay, density and organic matter. The water holding capacity decreased as the sand, voids ratio and porosity of the soil increased. They were suggested that the permeability of soil tested lies within the desirable range and suitable management practices should be adopted in the case of sandy loam and sandy soil.

Sharma *et al.* (2010) analyzed the soil samples (0-23 cm) randomly from 35 sites representing different locations of Uttar Pradesh and reported that the pH value, EC and organic carbon ranged from 6.3 to 8.9; 0.03 to 1.30 dSm^{-1} and 0.03 to 0.95%, respectively. The available nitrogen varied from 78.0 to 472.5 kg ha^{-1} with a mean value of 208.0 kg ha^{-1}. Thus, the most of the soils were observed deficient in available nitrogen. The soils of central and eastern tract of Uttar Pradesh was poor in available phosphorus, while moderate in western tract of Uttar Pradesh, and thus ranged from 2.18 to 77.77 kg ha^{-1}. The most of the soils were although medium in available potash.

Kumar and Babel (2011) analyzed surface (0-30 cm) soil samples from wheat growing fields of Jhunjhunu district of Rajasthan and reported that the sand, silt and clay content of the soil ranged from 76.70 to 90.40, 1.30 to 7.50 and 5.20 to 12.90 %, respectively and soils were categorized as sandy, loamy sand and sandy loam in texture. **Verma and Sharma (2005)** reported that soil of Rajgarh tehsil of Churu District, Rajasthan was sandy in nature and its texture varied from sandy to sandy loam.

Jayaprakash *et al.* (2012) analyzed the surface soils (0-20 cm) to know the macro nutrient status of non- traditional growing areas by taking 100 representative surface samples from Arecanut gardens of different talukas pertaining to non- traditional areas, they reported that pH ranged from neutral to alkaline in nature and electrical conductivity was within permissible limit. Most of macro nutrient status indicates that majority of the samples ranged from medium to high.

Singh *et al.* (2015) surface soil of the farmer's field from different village of Raisinghnagar block of Sri Ganganagar district, were sampled randomly to a depth of 0-15 cm in V shape with the help of Khurpi from 27 villages of Raisinghnagar block was presented in table Four soil samples were collected from each village. The Soil sample was mixed thoroughly and about a half kilogram of composite samples from farmer's field at different villages was taken for analysis. Collected surface soil sample (0-15 cm depth) were brought into laboratory and dried in shade at room temperature. Air dried soil samples were crushed with the help of wooden roller and sieved through 2 mm sieve. Finally dried soil samples were kept in a polythene bag for further physico-chemical analysis.

Singh *et al.* (2016) selected 38 surface soil samples (0-15 cm) were collected in butter paper bag as per the standard procedure. Quartering technique was used for preparation of soil sample. The samples were dried in air and passed through 2 mm sieve and stored in cloth bag. The soil pH and EC were determined from the saturation extract (1:2.5 soil water ratio) of soils Jackson .The soil samples were analyzed for organic carbon Walkley and Black, available N Subbiah and Asija, available P Olsen *et al.*available K Hanway and Heidal.

Singh *et al.* (2017) surface soil of the farmer's field from different villages of Lahar block in Bhind district, were sampled randomly to a depth of 0-15 cm in V shape with the help of khurpi from different village of Bhind district. The Soil sample was mixed thoroughly and about a half kilogram of composite samples from farmer's field at different villages was taken for analysis. Soil sample were brought into laboratory and dried in shade at room temperature. Air dried soil samples were crushed with the help of wooden roller and sieved through 2 mm sieve. Finally dried soil samples were kept in a polythene bag for further physico-chemical analysis. Bulk Density was determined by clod method (Black, 1965). Maximum water holding capacity was measured by Piper (1966).

2.2 Chemical properties in soil

Mathur and Yadav (2006) were analyzed for important soil characteristics such as pH, EC, organic carbon, $CaCO_3$ and CEC of the fifty surface soil samples of northwest plain soils of Rajasthan.They reported that soil was slightly alkaline in reaction. The pH of the soils varied from 7.2 to 8.60. Electrical conductivity ranged from 0.20 to 2.60 dSm^{-1} and majority of the irrigated soils in northwest plain zone were low in organic carbon content and medium level of calcium carbonate and CEC values.

Nirawar and Mali (2009) found that analyzed samples were neutral to moderately alkaline in reaction, safe limit in EC, low too high in organic carbon and no calcareous to calcareous in nature. The results further indicated that soils were low to medium in available N and P while, available K was medium to high range.

The available P showed significant negative correlation with soil pH while, EC had significant.

Vijayakumar *et al.* (2011) analyzed hundred surface soil samples representing eighteen villages of the recently tsunami affected areas of Sirkali taluk of Tamilnadu in India. The distribution of basic soil parameters viz., pH, EC, OC and OM and macronutrients viz., N, P, K was studied using standard methods. The macro nutrient status and their relationship with soil properties were also studied. The result showed that the available macronutrients N, P, K was85% low and 15% medium for N, 100% low for P and85% medium and 15% high K respectively.

Patil *et al.* (2012) collected soil samples from different areas of Jambughoda wildlife sanctuary. Stratified Random Samples were collected from surface as well as 10, 20 and 30 cm depths. Analyzed for macronutrients, micronutrients, organic carbon and organic matter. The amount of carbon sequestered was also calculated in kg ha^{-1}. Significant variations were seen in organic carbon content among samples collected from different places as well as from different depths. The average pH content of the soil samples was also measured.

Adejumobi *et al.* (2014) studied the effects of irrigation practices on the soils of Omi irrigation scheme Kogi state, Nigeria after 13 years of operation. Soil samples were taken at depths 0 – 20 cm (A1), 20 – 80 cm (A2) and 80 – 120 cm (A3) from two operating lands (OL); OL 5 and OL 18 of the study area. The samples were analyzed for chemical parameters (pH, CEC, ESP, Mg^{2+}, Ca^{2+}, OM, and OC). The soil pH which was in the neutral range (pH=6.65 to 7.00) at inception of scheme, has become slightly acidic (pH=6.53 to 6.60). Cation exchange capacity (CEC) levels have also increased from 10cmol^{+} kg^{-1} to 35cmol^{+} kg^{-1}. While Organic matter (OM) and Organic carbon (OC) also have marked increase in their levels (baseline as 0.93 to 1.08; for year 2013 as 9.52 to 9.79). Generally, the analysis indicated a need for proper monitoring of the scheme soil to prevent further deterioration.

Gajbhiye and Bhoye (2014) collected soil samples grouped into three orders viz, Vertisols, Inceptisols and Entisols. Out of the total surveyed soil samples, 37 % soil samples were grouped under Vertisols while, 40 and 23 % soil samples were grouped under Inceptisols and Entisols, respectively. These soil samples were analyzed for chemical properties and nitrogen fractions. The soils of Lohara tehsil were alkaline in reaction and 23% found safe in limit of electrical conductivity for growing crops. Organic carbon content in study area was low to medium while, these soils were calcareous in nature. Available nitrogen was categorized as low while, total and other remaining forms of N were noted as low to medium in soils. The pH, EC and $CaCO_3$were negatively but significantly correlated with nitrogen forms however, organic carbon was positively and significantly correlated with all forms of nitrogen under Vertisols, Inceptisols and Entisols of Lohara tahsil of Osmanabad district.

Nath (2014) studied the relationship between some physical and chemical properties of soil such as, sand content, total organic matter content and macronutrients with bulk density for sixty surface soil samples (0-15 cm) from ten tea estates. The sand, silt and clay content of soil samples ranged 74.87-88.24, 0.02-0.04 and 11.74-25.11% respectively; the values of bulk density for the tea estate soil varied from 0.98-1.29 g cm^{-3} soil pH varied from 4.60 to 5.57 electrical conductivity varied from 0.09 to 0.47 dS m^{-1}total organic matter content ranged 1.86 to 3.09 % available nitrogen status varied from 178 - 297 kg ha^{-1}. The average phosphorous content varied from 5.90 to 19.00 kg ha^{-1} and available potassium content in the soils ranged 214 to 291 kg ha^{-1}. Soil bulk density showed negative relationship with soil pH, electrical conductivity, total organic matter and macronutrients but showed positive relationship with sand content.

2.3 Status of available Macro- nutrient viz. N,P, K,and S in soil

2.3.1 Status of available Nitrogen and Their Relationship with Soil Properties

Nitrogen is the one of the most frequently deficient nutrient in Indian soils. Many inorganic and organic sources of N are found in the country to supply nitrogen to crop. The total soil nitrogen content range from <0.02% in sub soil to >2.5% inorganic soil. Soil N occurs as inorganic or organic N where about 95% of total N in surface soil is in organic N and rest inorganic nitrogen. Nitrogen is an essential part of proteins and is a constituent of physiologically important compounds like nucleotides, phosphatides, vitamins, enzymes and hormones. Nitrogen is also essential for carbohydrate use within plants. A good supply of nitrogen stimulates root growth and development as well as the uptake of other nutrients.

Kumar *et al*. (2009) reported that available N content of Dhumka and Lachimpur series varied from 125 to 310 kg ha^{-1} with a mean of 216 kg ha^{-1} and 210 to 545 kg ha^{-1} with a mean of 401 kg ha^{-1} respectively.

Singh and Mishra (2012) available nitrogen status varied from 154.4-342.2 kg ha^{-1} with an average value of 214.8 kg ha^{-1}. On the basis of the ratings suggested by Subbiah and Asija (1956), 78% of the soil samples were found to be low (< 250 kg ha^{-1}) and remaining in the category of medium (250-500 N kg ha^{-1}). Low nitrogen status in the soils could be due to low amount of organic carbon in the soils. A significant positive correlation (r = 0.930) was found between organic carbon and available nitrogen. Since most of the soil nitrogen is found in organic form, therefore, this relationship was observed. Available nitrogen was negatively correlated (r = -0.476) with pH..

Jyotsana *et al.* (2013) suggested that soils play an important role to describe the economic growth of the study area. Soils of low level flood plains near Varuna River, is very fertile in nature without adding any nutrient in it organic carbon present in sufficient amount in soils of low level flood plains. Macro nutrients viz., N, P, K and S govern the fertility of soils. Twelve representative villages were selected in the study area. The total study area of lower Varuna basin is around 23.05 sq. km. and different number of soil samples (0-15cm) were collected and analyzed for their physical status and chemical property and also analyzed for macro nutrient like available nitrogen (N), phosphorous (P), potassium (K), and Sulphur (S) status. Soil samples were found low in available P while medium in organic carbon and available N and K. While about 86% samples were found deficient in available Sulphur.

Ravikumar and Somashekher (2013) plants take up nitrogen generally as nitrates under aerobic conditions and as ammonium ions during anaerobic conditions. Nitrogen is most often the limiting nutrient for the plant growth. The nitrogen content is very low (< 272 kg ha^{-1}) in all the soil samples in the study area. Excess soil moisture content is one of the important factors affecting nitrification in water logged soils and is having a major contribution to vary the process. Since excess water is found in water logged areas, soil suppresses the process of nitrification because of deficient oxygen. Unlike in dry soils as in case of our study area soils however, do have enough moisture for the bacterial metabolism and the moistening of such soils rapidly increases the rate of biosynthesis of nitrogen. All the soil samples were having low available nitrogen content, ranging from 6.27 to 25.09 kg ha^{-1} and it is essential to apply organic wastes as an important source of nutrient to the agricultural fields.

2.3.2 Status of available Phosphorus and Their Relationship with Soil Properties

Phosphorus is one of the least available and least mobile mineral nutrients to the plant in soil and crop based on its contribution to the biomass as macronutrients. Many soils have large reserve of total P, often hundred times more than P available to the crop **(Ali-Abbas and Barber, 1964)**. The organic phosphorus compounds may account for more than half of the total soil phosphorus and a constituted major part of total phosphorus. The phosphorus is taken up by growing plants obtained mainly from organic form of phosphorus. P is the major constituent of many enzymes associated with transformation of energy, in metabolism of carbohydrate and also in respiration in plants. It has important role to play in cell division and root development. Phosphorus counteracts the effects of excessive nitrogen and brings about early maturity of cereals. It improves the quality of food grains. About 49% of Indian soils are deficient in P. in P deficient soils the plant develop visual deficiency symptoms, viz. they fail to make a quick start, develop poor root-system, remain stunted. Being mobile nutrient in plants, it is easily Trans located from older tissues or leaves to the meristemetic or new leaves and hence the older leave develop characteristic symptoms of dark to blue-green coloration starting from the tips towards the base, which later turn reddish brown.

Kumar *et al.* (2007) concluded that the application of 60 kg P_2O_5 ha^{-1} in both plant and ratoon crops was to be most beneficial and gave highest cane yield.

Rajeswar *et al* .(2009) reported that the available phosphorus content in all the pedons varied from 5.3 to 33.4 kg ha^{-1}.However, the highest available phosphorus was observed in the surface horizons and decreased regularly with depth and higher P in surface horizon in soil of Garikapadu of Krishna District of Andhra Pradesh.

Singh and Mishra (2012) the available phosphorus content varied from 8.2 -1 -1 to 25.0 kg ha^{-1} with a mean value of 12.8 kg ha^{-1}. On the basis of the limits suggested to Muhr*et al.* (1963), most of the soil samples (94 %) were low (< 20 P O kg ha^{-1}) in available 25 phosphorus status and rest were under medium (20-50 kg ha^{-1}) category. A significant positive correlation (r = 0.625) was observed between organic carbon and available phosphorus. This indicates that presence of organic matter increases the availability of phosphorus in soil. About 50% of phosphorus is found in organic form and decomposition of organic matter produces humus which forms complex with Al and Fe and protects the P fixation. Available phosphorus and clay was found to be significantly and positively correlated (r = 0.316) with each other because the retention of added phosphorus increased with an increase of clay.

Achat (2013) evaluated P status of surface and deep soil horizons from different forest plots in south-western Siberia and assessed the effects of physico-chemical soil properties, microbiological activity and decomposition processes on soil P fractions and availability. Results revealed high concentrations of total P (879–1042 mg kg^{-1} in the surface mineral soils) and plant-available phosphate ions. In addition, plant available phosphate ions accumulated in the subsoil, suggesting that deeper root systems may mine sufficient available P for the trees and the potentially enhanced growth and C sequestration, may not be P-limited. Because the proportions of total organic P were large in the surface soil layers (47–56% of total P), we concluded that decomposition processes may play a significant role in P availability. However, microbiological activity and decomposition processes varied between the study plots and higher microbiological activity result din smaller organic P fractions and consequently larger available inorganic P fractions. In the studied Siberian soils, P availability was also controlled by the physicochemical soil properties, namely Al and Fe oxides and soil pH.

Singh *et al.* (2015) The available phosphorous content in these soils varied from 0.15 to 32 kg ha^{-1} with a mean value of 25.59 kg ha^{-1}, On the basis of the limits suggested to Muhr*et al.* (1963) most of the soil samples (37%) were medium (12.5 to 25 kg P ha^{-1}) in available phosphorus status and 63% were under high

(>25 kg P ha^{-1}) category. It is a constituent of the cell nucleus, essential for cell division and the development of meristematic tissues at the growing points. It makes 0.1 to 0.5% of dry weight of the plant. According to Gupta et al. the normal value of phosphorus in soil should be (12.5 to 25 kg ha^{-1}). Higher P may be due to fixed phosphorus pool of phosphate contains inorganic phosphate compounds that are very insoluble and organic compounds that are resistant to mineralization by microorganisms in soil. These findings are in agreement with the results reported by Meena*et al*. (2006) in soil of Tonk district of Rajasthan.

Singh *et al.* (2016) The available phosphorous content in these soils were varied from 12.9 to 35.9 kg ha^{-1} with a mean value of 26.03 kg ha^{-1}.S.D value of 6.535 and C.V. value of 25.10%. Out of 38 soil samples collected 85.70% soil samples were found medium, 14.2% soil samples found high in P content. This may be due to phosphorus build up in soil because of high phosphatic fertilizer application.

Singh et *al.* (2017) The available phosphorous content in these soils were varied from 18.5 to 90.50 kg ha^{-1} with a mean value of 35.74 kg ha^{-1} .S.D value of 1.33 and C.V. value of

25.10%. Out of 67 soil samples collected 11.94%soil samples were found medium, 88.05% soil samples found high in P content.This may be due to phosphorus build up in soil because of high biomass in soil, or, phosphatic fertilizer application.

2.3.3 Status of Available Potassium and Their Relationship with Soil Properties

Out of the essential elements, potassium is the third most likely nutrient element, after nitrogen and phosphorus, to limit plant productivity. The K content in Indian soil varied from less than 0.5% to 3.5%. The total K content of the soil is not an indicator of its available status. The reserve K (Mineral K and non-exchangeable K) can be visualized as a donor of K over a large period of time. Distribution of K in Indian soil is available K, non-exchangeable K, and lattice K which is constituted 0.92, 4.1 and 95 % of the total K, respectively

Available potassium content in Indian soil was found to be low in 76 districts while it was medium too high for 190 and 105 districts; respectively **(Tendon and Sekhon, 1988)**.It is evident from the soil testing data at several locations that the higher category of K has now decreased by 6.5% during the last two decades. Potassium addition is less than its removal by crop. The K mining is many time higher than that of N and P. it has been estimated that crop removal of N, P and K from the soil would be about 37 million tons by the year 2020, of which K uptake alone would be about 20 million tons. Therefore, K additions through all sources need to be encouraged. Potassium is involved in regulating the opening and closing of the stomata, (which is essential for photosynthesis), water and nutrient (NO_3^-, PO_4^{3-}, Ca^{2+}, Mg^{2+} and amino acids) transport and cooling of plants, improves the size of grains of cereals. It increases root growth, and thereby improves tolerance of plants to stress of moisture or drought, heat, disease and lodging.

Arora and Chahal (2007) investigated the distribution pattern of different forms potassium in benchmark soils of Punjab. They reported that the available K content in soil varied from 41.5 to 314.0 mg kg^{-1} in surface containing 32.0 to 243.0 mg kg^{-1} in sub surface soils.

Jibhakate *et al.* (2009) studied the physico-chemical status of soils of kotal tehsil in Nagpur district and found that the available potassium of these soils was ranged from 319.10 to 554.00 kg ha^{-1}.

Vijayakumar (2011) status of available potassium (K_2O) in the soils ranged from 135.85 – 432.25 kg ha^{-1} with an average of 237.37 kg ha^{-1}. According to Muhr*et al* (1963)85% samples were medium (125- 300 kgha^{-1}) and 15% high in potassium content. This might be due to creation of favorable soil environment with the presence of high organic matter.

Pulakeshi *et al.* (2011) studied soil of mantagani village of north Karnataka found that the available potassium content in major portion of the study area was in medium and high category. Black soils were higher in available potassium status than red soil which may be due to predominance of K rich micaceous and feldspars minerals in parent material.

Singh and Mishra (2012) status of available potassium in the soils ranged between 134.6 and 310.4 kg ha^{-1} with an average of 201.7 kg ha^{-1}. According to Muhr*et al.* (1963), most of the soil samples (96 %) were found under medium (125-300 kg ha^{-1}) range. A significant positive correlation (r = 0.625) was observed between organic carbon and available K content. This might be due to creation of favorable soil environment with presence of organic matter. Similar relationship was also reported by Chauhan (2001). Significant positive correlation was also found between available potassium and clay content. It might be due to the presence of most of the mica (biotite and muscovite) in finer fractions.

Singh *et al.* (2015) status of available potassium content in these soils ranged from 290 to 482 kg ha^{-1} with a mean value of 367.57 kg ha^{-1}. According to Muhr*et al.* (1963) Out of 108 soil samples, 37% soil samples were found under medium (135 to 335 kg K ha^{-1}) range and 63% soil samples under high (>335 kg K ha^{-1}) available potassium. The higher value of K content indicates the presence of micaceous parent minerals. Pulakeshi*et al.* (2012) observed similar results from soils in Mantagani village of North Karnataka.

Singh *et al.* (2016) The potassium content in these soils was ranged from 125.8 to 237.6 kg ha^{-1} with a mean value of 193.83 K kg ha^{-1}S.D. value 35.58 and C.V. value of 17.32%. Out of38 soil samples 5.7% soil samples were found low, 94.2% soil samples were found medium and no any sample founded high in K content.

Singh *et al.* (2017) available potassium (K_2O) in the soils ranged from 300.22 to 418.30 kg ha^{-1} with an average of 355.05 kg ha^{-1}. According to limits suggested by Muhr*et al.* (1963) 100% samples were high (>300 K_2O kg ha^{-1}) in potassium content. Status of secondary nutrient in soil range is (S, Ca, Mg) 16.58 - 28.68, 4.50-9.05 and 2.73-6.99, respectively. On the basis of the ratings suggested by Ramamoorthy and Bajaj (1969) 40 % were medium (10-20 kg ha^{-1} S) and 60 % high (>20 kg ha^{-1}), calcium and magnesium are found in (100%) sufficient. This might be due to creation of favorable soil environment with presence of high organic matter. Similar results were reported by Chauhan (2001).

2.3.4 Status of available Sulphur and Their relationship with soil Properties

Patel *et al.* (2011) analyzed soils from four hundred eighty soil samples collected from Banaskantha district to study the different forms of sulphur in soil and 23 reported that total S ranged from 32.72 to 346.83 mg kg^{-1} in surface layer (0-15 cm depth) and 34.3 -307.30 mg kg^{-1}in sub-surface soil (15-30 cm depth).

Jayaprakash (2012) found that soil reaction in different soil profiles of Karnataka varied from medium acidic to strongly alkaline and ranged from 5.6 to 8.5, decreased with increasing depth. Cation exchange capacity in different soil profiles ranged from 9.00 (cmol (P^+) kg^{-1}) to 24.00 (cmol (P^+) kg^{-1}) it showed decreasing trend with increasing depth. Exchangeable calcium in profile bodies varied from 1.8 (cmol (P^+) kg^{-1}) to 4.2 (cmol (P^+) kg^{-1}). Exchangeable magnesium of soil profiles was in the range of 0.89 (cmol (P^+) kg^{-1}) to 3.5 (cmol (P^+) kg^{-1}). Available sulphur in different soil profiles was in the range of 8 ppm to 18.5 ppm and was highest in surface horizon. It gradually decreased with depth in all the soil.

Singh and Mishra (2012) the available sulphur status varied from 6.0-16.6 ppm with a mean value of 9.5 ppm. Plant roots absorbsulphur in the form of SO from the soil solution. Keeping this fact in view, the soil under study may be classified as deficient (< 10 ppm), medium (10-20 ppm) and sufficient (>20 ppm) category as per the categorization these categories, 62% samples were found under deficient and remaining 38% samples were found under medium category. Thus, the soils of Chiraigaon block of district Varanasi are likely to respond to sulphur fertilization. A positive correlation (r = 0.051) was observed between organic carbon and available sulphur content. This relationship was existed because most of the sulphur is associated with organic matter.

Chapter-III

MATERIALS AND METHODS

This chapter deals with the materials used and methods employed during the course of the investigation to evaluate the **Soil quality status of different villages in Narayanpur block of Mirzapur district, Uttar Pradesh.** The information on the experimental area and other details are presented in the following sections.

3.1 Description of Site

3.1.1 Location

Narayanpur block is one of the seven block of Mirzapur district, Uttar Pradesh India.

1) It is located in eastern-northern area of the district. It is located 55 Km towards Northern from District headquarters Mirazapur.

3.1.2 Geography

Mirzapur district is situated in the northern part of the Uttar Pradesh and covers an area of about 4521 sq. km. It lies between Latitude 25° 15' and 82° 58' longitude. The district is bounded on north by SantRavidas Nagar and Varanasi districts, on the east by Chandauli district, on the south by Sonbhadra district and on the northwest by Allahabad district. Mirzapur district is divided into 4 tehsils and 12blocks. It has 1698 villages.

3.1.3 Soil

The soil in the district generally falls under the red laterite soils, alluvial soils, and black soils. Color of the soil varies from brown, yellowish brown to dark gray brown. Texture of soils varies from sandy loam (below 20% clay), loam (20 – 30% clay), clay loam (30 – 40% clay) & clay (more than 40% clay). Clay loam soil found in some parts of Narayanpur block.

3.1.4 Agro Climate

The study are comes undersemi-arid to arid type of climate and Agro-climate Zone's Irrigated north plain of Uttar Pradesh.The normal rainfall if the district is 1081.1 mm. District receives maximum rainfall during south west monsoon period *i.e.* June to September. About 87.40% of the annual rain fall precipitates during the monsoon season. Thus surplus water for ground water recharge is available during the period from June to September. During the southwest monsoon season the relative humidity generally exceeds 83% (August month). In the rest of the period is dry. The driest period is summer season, when relative humidity is less than 26%. May is the driest month of the year.

3.1.5 Temperature

The climate of Mirzapur district varies to temperature limits. Normal maximum temperature during the month of May is 47^0C and minimum during December- January month is 4^0C. Normal mean maximum & minimum temperature is 35^0C & 21.8^0C, respectively.

3.1.6 Land use

Rainfed agriculture is the tradition farming practice followed in the region. The crops cultivated under rainfed conditions are Mustard, Gram and Rapeseed in *Rabi* season, While Wheat, Barely, Mustard and Gram are cultivated under irrigated condition and seasam, Bajra, Arhar, Rice and Sorghum are cultivated under *Kharif* season. Land use and other agricultural characteristics of the study area are presented in table 3.1.

Table 3.1: Land use and other agricultural characteristics of the study area in Mirzapur District (2013)

S.No.	Agricultural parameters	Area $(Km)^2$
1	Geographical area (GA)	4521
2	Forest area	109.23
3	Land not available for cultivation – Non agricultural uses	48.97
4	a) Current fallows b)Other fallows	39.66 10.04
5	Pasture land	0.51
6	Net cropped area (NCA)	191.38
7	Area sown more than once	81.44
8	Total cropped area	272.82
9	Intensity of cropping	142.60
10	Cultivable waste land	13.85
11	Net irrigated area	120.49
12	Gross irrigated area	162.15
13	Rainfed area	70.89

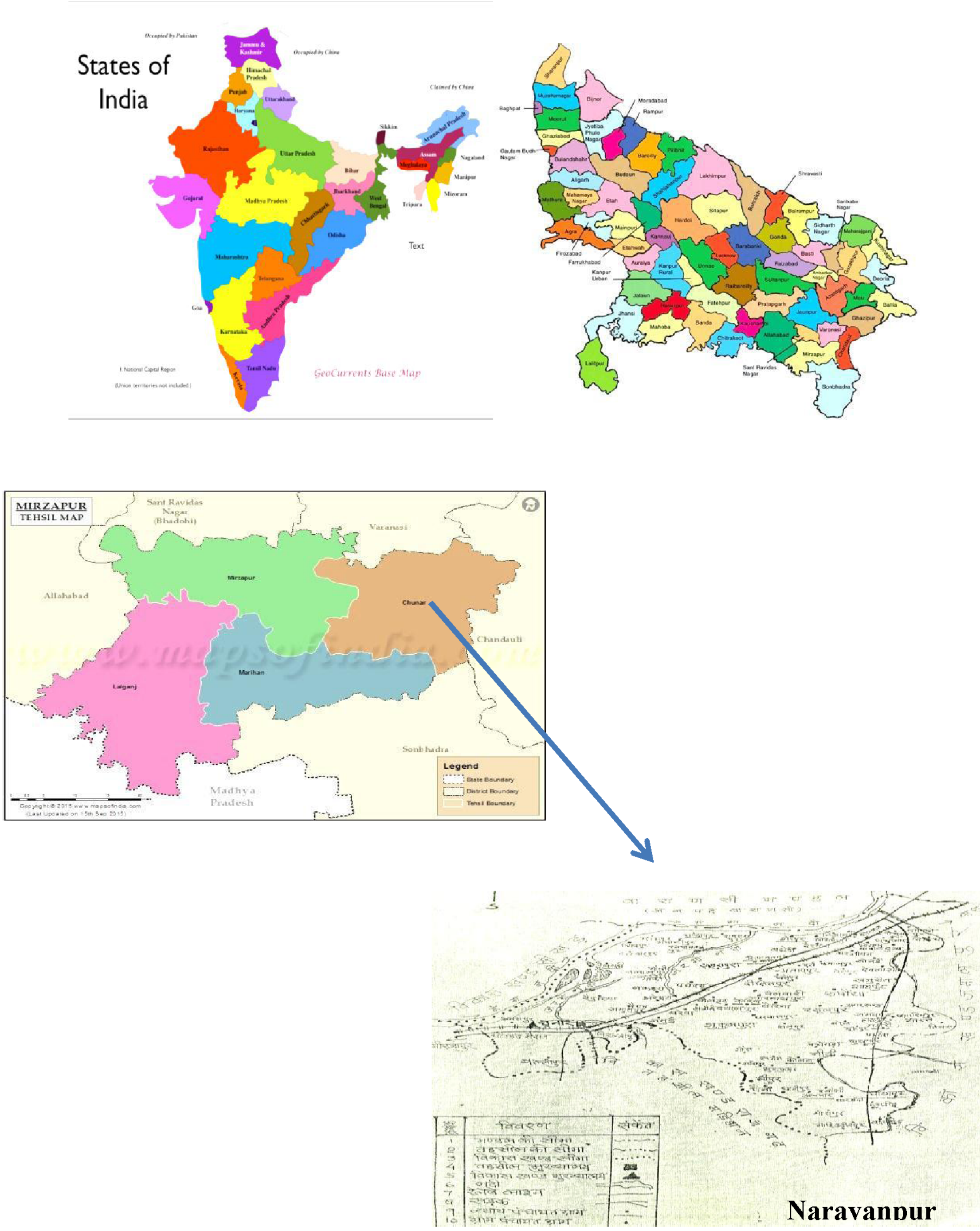


Fig. 3.1: Location of Narayanpur block in Mirzapur district.


GEOLOGICAL & MINERAL MAP OF DISTRICT MIRZAPUR
SCALE 1:250,000
83°00'
N
VARANASI
To Varanasi
GANGA RIVER
KACHHWA
To Allahabad
MIRZAPUR
CHUNAR
BHUILI
VIJAYPUR
PANTHARI SHIVGARH
VARANASI
ALLAHABAD
AHRAURA
25°00'
LALGANJ
208
LATIF PUR
SAKTES GARH
BARAUNDHA
MARIHAN
318
220
RAJ GARH
DRAMOND GANG
411
SIRSI
PALIYA
KASIYARA
SONBHADRA
83°00'
LEGEND
GEOLOGY
Alluvium
Laterite
Kaimur sst.
MINERAL
Building Stone

3.2 Method of Soil Sampling and Processing

3.2.1 Collection of soil sample

Surface soil of the farmer’s field from different village of Narayanpur block of Mirzapur district, were sampled randomly to a depth of 0-15cm in V shape with the help of khurpi from different village of Mirzapur district. The Soil sample was mixed thoroughly and about a half kilogram of composite samples from farmer’s field at different villages was taken for analysis. Ground water samples were collected from Mirzapur district Narayanpur block from tube well and open wells. Description of sampling sites presented in table 3.2.

3.2.2 Laboratory work

Collected surface soil sample (0-15 cm depth) were brought into laboratory and dried in shade at room temperature. Air dried soil samples were crushed with the help of wooden roller and sieved through 2 mm sieve. Finally dried soil samples were kept in a polythene bag for further physico-chemical analysis.

3.3 Analysis of Soil Samples

The soil samples were analyzed for the physico-chemical properties *i.e.* mechanical analysis, soil pH, electrical conductivity, organic carbon, available nutrient (N, P, K, and, S) of soil. Standard procedures followed for physico-chemical analysis of soil are presented in table 3.3.

3.3.1 Soil pH

A soil water suspension was prepared in the ratio of 1:2.5 (10 g soil with 25ml of distilled water) and pH was measured with the help of pH meter (Jackson, 1973).

3.3.2 Electrical conductivity

The same soil suspension of pH was used and allowed for setting till supernatant become clear. Washed electrode of EC meter with distilled water was dipped in supernatant suspension at room temperature and reading was noted (Jackson, 1973).

Table 3.2: Description of soil sampling sites

S.No.	Villages	Sample No.	Farmer's Name	Cropping pattern	GPS Location
1	Ghurahupur	S_1	Shri Neeraj Singh	Rice-wheat-fallow	826,N25^{0}07.520E082059.697
2		S_2	Shri Dinesh Singh	Rice-wheat-fallow	827,N25^{0}07.316E082^{0}59.45
3		S_3	Shri Rahul Kumar Singh	Rice-wheat-fallow	828 N25^{0}07.347E082^{0}59.849
4		S_4	Shri Niraj Kumar Singh	Rice-wheat-fallow	829 N25^{0}07.352E082^{0}59.898
5		S_5	Shri Lakchhaman Singh	Rice-wheat-fallow	830 N25007.410E082^{0}59.951
6	Rajupur	S_6	Shri Kanhaya Singh	Rice-wheat-fallow	831 N25007.618 E082^{0}59.881
7		S_7	Shri vijay Singh	Rice-wheat-fallow	832 N25007.574 E082^{0}59.869
8		S_8	Shri Subash Singh	Rice-wheat-fallow	833 N25007.549 E082^{0}59.854
9		S_9	Shri Rajendra Singh	Rice-wheat-fallow	834 N25007.520 E082^{0}59.845
10		S_{10}	Shri Bachchan Singh	Rice-wheat-fallow	835 N25007.490 E082^{0}59.815

Table Contd…

S.No.	Villages	Sample No.	Farmer's Name	Cropping pattern	GPS Location
11	Kolana	S_{11}	Shri Harikinkar Singh	Rice-wheat-fallow	836 N25007.077 $E082^0 59.399$
12		S_{12}	Shri Avadhesh Singh	Rice-wheat-fallow	837 N25007.058 $E082^0 59.392$
13		S_{13}	Shri Babulal Singh	Rice-wheat-fallow	838 N25007.137 $E082^0 59.516$
14		S_{14}	Shri Ashish kumar Singh	Rice-wheat-fallow	839 N25007.186 $E082^0 59.553$
15		S_{15}	Shri Anil Kumar Singh	Rice-wheat-fallow	840 N25007.458 $E082^0 59.409$
16	Naharipur	S_{16}	Shri Ajay Kumar	Rice-wheat-fallow	841 N25007.428 $E082^0 59.387$
17		S_{17}	Shri Ankit Singh	Rice-wheat-fallow	842 N25007.504 $E082^0 59.412$
18		S_{18}	Shri Babalu Singh	Rice-wheat-fallow	843 N25007.554 $E082^0 59.428$
19		S_{19}	Shri Dharanjay Kumar Singh	Rice-wheat-fallow	844 N25007.581 $E082^0 59.809$
20		S_{20}	Shri Niles Kumar Singh	Rice-wheat-fallow	845 N25007.201 $E082^0 59.628$

S.No.	Villages	Sample No.	Farmer's Name	Cropping pattern	GPS Location
21	Pahadi	S_{21}	Shri Ashveeni Kumar Singh	Rice-wheat-fallow	846 N25007.475 E082^{0}59.710
22		S_{22}	Shri Gurucharan Singh	Rice-wheat-fallow	847 N25007.494 E082^{0}59.703
23		S_{23}	Shri Sushil Kumar Singh	Rice-wheat-fallow	848 N25007.563 E082^{0}59.662
24		S_{24}	Shri Vinod Singh	Rice-wheat-fallow	849 N25007.594 E082^{0}59.676
25		S_{25}	Shri Anand Singh	Rice-wheat-fallow	850 N25007487 E082^{0}59.700
26	Bangala	S_{26}	Shri Shivendar Kumar Singh	Rice-wheat-fallow	851 N25007.721 E082^{0}59.898
27		S_{27}	Shri Komal Singh	Rice-wheat-fallow	852 N25007.735 E082^{0}59.903
28		S_{28}	Shri Ravishankar	Rice-wheat-fallow	853 N25007.750 E082^{0}59.931
29		S_{29}	Shri Rajat Singh	Rice-wheat-fallow	854 N25007.705 E082^{0}59.957
30		S_{30}	Shri Vijendra Kumar	Rice-wheat-fallow	855 N25007.775 E082^{0}59.946

Table 3.3: Procedure used for physico-chemical analysis of soil

Properties	Method followed	Reference
Physical properties		
Bulk density(Mg m^3)	Pycnometer	Black *et al.* (1965)
Particle density(Mg m^3)	Pycnometer	Black *et al.*(1965)
Chemical properties		
pH	Glass electrode pH meter	Jackson (1973)
EC(dSm^{-1})	Electrical conductivity meter	Jackson (1973)
Organic carbon (%)	Wet oxidation method	Walkey and Black (1934)
Available Nitrogen (kg ha^{-1})	Alkaline $KMnO_4$ method	Subbiah and Asija (1956)
Available Phosphorus (kg ha^{-1})	Bray's method Olsen's method	Bray and Kurtz (1945) Olsen *et al.* (1954)
Available Potassium(kg ha^{-1})	Ammonium Acetate method	Hanyway and Heidal (1952)
Available Sulphur (kg ha^{-1})	Calcium chloride method	Chesnin and Yien (1950)

3.3.3 Bulk density

The clean dry pycnometer was taken and weighed on electric balance. Soil was filled in pycnometer with help of spatula up to brim. After that weight of the pycnometer with soil was taken. Then, the soil was removed from pycnometer. A burette was filled with water and water and water was dropped in the same pycnometer from burette until the pycnometer was the completely filled with water. The reading will give the actual volume of pycnometer (Black *et al.,* 1965).

3.3.4 Particle density

The clean and dry pycnometer was taken and weighed. Water was filled in pycnometer and weighed .Take a beaker and put 10g oven dried soil in it and 10ml of water was added to it, heat it to expel the air. When bottle was half filled the soil particles sticking to inner side of the neck were washed by using pipette. Inserted the stopper and wiped the surface of the pycnometer, dried and weighted it (Black *et al.*,1965).

3.3.5 Organic Carbon (Walkley and Black, 1934)

Procedure: 1 g of soil was taken in a 500 mL of conical flask. 10 mL of 1*N* $K_2Cr_2O_7$ solution was added and mixed. Then 20 mL of conc. H_2SO_4 was added, the flask was swirled 2-3 times and allowed to stand for 30 minutes on an asbestos sheet for the reaction. The suspension was diluted with 200 mL of distilled water. 10 mL of 85% H_3PO_4 and 1 mL of diphenyl indicator were added and titrated against the solution of 0.5*N* Ferrous Ammonium Sulphate till color changed from violet to bright green. A blank titration was also carried out.

Calculation:

$$\text{Organic 'C' in soil (\%)} = \frac{(B-T) \times 0.003 \times 100}{2 \times \text{wt. of soil}}$$

Where,

B = Volume of 0.5*N* FAS solution used for blank titration

T = Volume of 0.5*N* FAS solution used for sample titration

3.3.6 Available nitrogen

Available Nitrogen content in soil was determined using Kjeltec Semi-Auto Nitrogen Analyzer (Pelican) by alkaline Potassium permanganate method as proposed by Subbiah and Asija (1956). The method has been widely adopted to get a reliable index of Nitrogen availability in soil due to its rapidity and reproducibility.

Procedure: Five g of soil sample was weighed and transferred in a distillation tube. The sample was moistened with 5 mL distilled water, washing down the soil adhering to the neck of flask. Twenty five mL 0.32% $KMnO_4$ was added to it and the distillation tube was set to the instrument. In a 250 mL conical flask, 20 mL of 2 % boric acid mixed indicator was taken and placed under the receiver tube. Tap water was run continuously in the condenser. Twenty five mL of 2.5% NaOH was sucked and added to the distillation tube. Then it was put on distillation for 9 min. During this process the N released in the form of ammonia is trapped in the boric acid, which develops green colour. The flask containing the distillate was removed. The distillate was then titrated against 0.02*N* H_2SO_4 until pink colour developed.

Calculation

$$\text{Mineralizable N (kg ha}^{-1}) = \frac{(S\text{-}V) \times 0.02 \times 14 \times 10^6 \times 2.24}{1000 \times 5}$$

Where,

S = Sample titration reading

V = Blank titration reading

3.3.7 Available Phosphorus

Available phosphorus content of soil was determined by Olsen's method (Olsen *et al.*, 1954). Firstly reagent A was prepared by using ammonium molybdate, antimony potassium tartarate and H_2SO_4. Then reagent B was prepared with the help of reagent A. Two gram of soil was taken in a 150 mL conical flask, a pinch of Darco G-60 and 40 mL of Olsen's reagent (0.5 M $NaHCO_3$) was added to it. It was then shaken for 30 minute on mechanical shaker and the suspension was filtered through Whatman No. 1 filter paper. Five mL of filtrate was transferred in a 25 mL volumetric flask and was acidified with 5*N* H_2SO_4 to pH 5.0 and distilled water was added, washing down the sides followed by

4 mL of reagent B and volume was made up to the mark with distilled water. After waiting for 10 min the intensity of blue colour was measured on spectrophotometer at 882 nm. Simultaneously a blank was also run. First standard reading was taken followed by sample reading.

Calculation

$$\text{Available Phosphorus kg ha}^{-1}) = \frac{\text{R} \times \text{Volume of extract} \times 2.24 \times 10^6}{\text{Volume of aliquot} \times \text{wt. (g) of soil} \times 10^6}$$

Where,

R = µg P in the aliquot (obtained from standard curve)

3.3.8 Available Potassium

Available potassium content of soil was determined by Flame Photometer (1 N ammonium acetate extract) method (Jackson, 1973). Five gram of soil was taken in a 100 ml conical flask and 25 ml of 1*N* ammonium acetate solution was added and shaken for 5 minutes. The suspension was then filtered through Whatman No. 1 filter paper and potassium concentration in the filtrate was measured using flame photometer. First standard reading was taken followed by sample reading.

Calculation

Dilution factor = 25 / 5 = 5 times

Reading of the flame photometer for the test sample = R

Concentration of K in the sample from standard curve against the reading R = C

Available K (kg ha^{-1}) = C x 5 x 2.0

= C x 10

Available K_2O (kg ha^{-1}) = C x 10 x 1.21

3.3.19 Available Sulphur

Soil was extracted with a solution of 0.15% Calcium chloride. Soluble sulphate was estimated in aliquot of the extract, using barium chloride in presence of gum acacia solution. The turbidity produced by barium sulphate was measured on spectrophotometer at 420 nm wavelength (Chesnin and Yien, 1950).The available Sulphur (kg ha^{-1}) was calculated as follows:

$$\text{Available Sulphur (kg/ha)} = \frac{A \times B \times C \times 2.24}{D \times E}$$

Where,

A = S (mg L^{-1}) in aliquot

B = Final volume of turbid solution (mL)

C = Volume of soil extractant used for extraction (mL)

E = Air dry soil weight (g)

3.4 Methodology for soil nutrients status evaluation

The characterization of the soils of the individual villages as a whole in to the three fertility classes was done according to the nutrient index values calculated from the soil test summaries giving their percentage distribution into low, medium and high categories. The nutrient index (Muhr *et al.*, 1965) was given by-

Nutrient index = [% in high category x 3 + % in medium category x 2 + % in low category x 1] / 100

In this percent assessment a nutrient index less than 1.5 denotes low category and that falls between 1.5 and 2.5 represents the medium fertility class. Value of 2.5 and above (maxi 3.00) signifies a high fertility class in respect of the particular nutrient (Ghosh and Hasan, 1976).

The rating of the individual soil test values into the three classes was performed according to the above mentioned limits. (Ramamoorthy and Bajaj, 1969) Which have been adopted by most of the soil testing laboratories in the country.

Table 3.4: Characterization of soil test values for different nutrients

Nutrients	**Rating of the soil test values**		
	Low	**Medium**	**High**
Organic carbon (%)	< 0.5	0.5 – 0.75	> 0.75
Available N(kg ha^{-1})	<280	280 – 560	>560
Available P (kg ha^{-1})	<12.5	12.5 – 25	>25
Available K (kg ha^{-1})	<135	135 – 335	>335
Available S (kg ha^{-1})	<10	10 – 20	>20
	Deficient	Sufficient	High

3.5 Statistical Analysis

Data obtained from all the observation were statistically analyzed. Correlation between various parameters, Range, Mean, Standard Deviation and Coefficient of Variation of all parameter in soils were calculated. The Coefficient Variation was determined by using formula:

$$C.V. = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

The relationship between relevant soil properties and available cationic micronutrient of soils were calculated by using standard statistical methods. The correlation coefficient was determined by using the formula: (Shedecon and Cochoram, 1967).

$$r = \sqrt{\frac{SP\,(xy)}{SS\,(x),\, SS\,(y)}}$$

Where,

r = Correlation coefficient

SP (xy) = Sum product of x, y variable

SS (x) = Sum of square of x variable

SS (y) = Sum of square of y variable

Chapter-IV

RESULTS AND DISCUSSION

Mirzapur district has different types of soils and subjected to intensive agriculture programme with variety crop of varying nutrient status since a long, which leads to nutritional imbalance particularly in N, P, K, and S whose availability range is very narrow. Concept of Nutrient index gives the basic data regarding available nutrients in the soil and their association with other soil characteristics. This can be widely utilized in specific set of condition. Very meager collective work on these widely spread soils have been carried out with respect to soil characteristics and nutritional status.

Narayanpur is one of the developing blocks of Mirzapur district of Uttar Pradesh, with varied soil type, so present investigation was under taken to study the physico-chemical properties and available nutrients status from Narayanpur block of Mirzapur.

4.1 Assessment of Soil Quality status

The data obtained from laboratory and statistical analysis was represented in tabulated and graphical form under the following heads.

4.1 Physico-chemical properties of soil.

4.2 Status of available primary macronutrients viz. N, P and K in soil.

4.3 Status of available secondary macronutrients viz. S, in soil.

4.4 Soil nutrient index value.

4.5 Correlation of physico-chemical properties with nutrient availability.

4.1 Physico-chemical properties of soil

The data on pH, EC, B.D., P.D. and Organic carbon are presented in tab 4.1. The data shows that the pH of these soils was ranged from 6.8 to 8.1 with average value of 7.71. The lowest pH (6.8) was recorded in soils of 11 Kolana. Village while highest pH (8.1) was observed in soils of Pahadi, village with S.D value of 0.44 and C.V. value of 5.58%.

Out of six village 33% soil samples were neutral (6.8 to 7.4), 43.33% soil samples were moderately saline (pH 7.5 to 8.0) and 23.33 % soil samples alkaline in reaction. The soils of Narayanpur block were neutral to moderately saline in reaction. Similar result was observed by Singh *et al.* (2015) in the district of Sri Ganganagar, district of Rajasthan.

The electrical conductivity of Narayanpur block was varied from 0.10 to 0.42 dS m^{-1} with an average value of 0.22 dS m^{-1}. The lowest EC (0.10) was recorded in Kolana village while, highest EC (0.42) was recorded from Pahadi village with S.D. value of 0.09 and C.V. value of 40.90%. Similar result was observed by Singh and Mishra (2012) in the district of Varanasi Uttar Pradesh.

Bulk density and Particle density ranged from 1.10-1.38 and 2.16-2.70Mg m^{-3} respectively with a mean of 1.28 and 2.35 Mg $m^{-3.}$ S.D. and C.V. of bulk density and particle density were 0.064, 5.03 and 0.10, 4.54 Mg m^{-3}. The lowest BD (1.10) was recorded in 15 Kolana Village while, highest B.D. (1.38) was recorded from 25

Pahadi village. Highest P.D. was observed in Ghurahupur 2.70 Mg m^{-3} and 2.16 Mg m^{-3} found lowest in Kolana. These results were confirmatory with result obtained by Pranagal and Chmielewska (2012) in soils of South- Eastern Poland.

The data on percent organic carbon content were ranges from 0.24 to 0.84 with a mean value 0.49, the lowest value (0.24) of organic carbon was observed in Kolana 12 village whereas highest value 0.84 was showed in soil of Ghurahupur village followed by with the S.D. value of organic carbon was 0.17 and C.V. value of Organic carbon was 35.62%, respectively.

Out of 30 soil samples collected from Narayanpur block of Mirzapur District 36.66 % samples were found medium, 50% samples were found low in organic carbon. Thus majority of the soil samples of Narayanpur block are low in their organic carbon status. The high temperature prevailing in the area is responsible for rapid decomposition of organic carbon. These finding are in agreement with the result reported by Mathur and Yadav (2006) in soil of North-west plain of Rajasthan and Singh *et al.* (2015) in the district of Sri Ganganagar, district of Rajasthan.

Table 4.1.1: Physical properties of soils of Narayanpur block

Soil characteristics	Range	Mean	S.D.	C.V. (%)
P^H (1:2.5)	6.8-8.1	7.71	0.44	5.58
E.C.(dSm^{-1})	0.10-0.42	0.22	0.09	40.90
B.D.(Mg^{-3})	1.10-1.38	1.28	0.064	5.03
P.D.(Mg^{-3})	2.16-2.70	2.35	0.10	4.54
O.C. (%)	0.24-0.84	0.49	0.17	35.62

Table 4.1.2: Classification of soil samples under different p^H range of Narayanpur block

Classes	Limit	No of samples	% Samples
Neutral	6.8-7.4	10	33.33
Moderately saline	7.5-8.0	13	43.33
Alkaline	8.1-8.8	7	23.34

Table 4.1.3: Classification of soil samples under different Organic carbon ranges of Narayanpur block

Organic carbon (%)	Limits (%)	No. of analyzed soil samples	% of analyzed soil samples
Low	<0.5	15	50
Medium	0.5-0.75	11	36.66
High	>0.75	4	13.33

4.2 Status of available N, P and K in soil

The status of N, P and K has been shown in table 4.2 and Fig No.3 its subparts. Available nitrogen content of these soils was ranged from 132.72 to 280.37 kg ha^{-1} with a mean value of 184.73 kg ha^{-1}. The lowest (132.72 kg ha^{-1}) nitrogen content was observed in soils of 6 Rajupur villages whereas the highest (280.37 kg ha^{-1}) nitrogen content was recorded in soils of 28 Bangala with S.D. value of 36.69 and C.V. value of 19.86%. Similar result was observed by Singh *et al* (2016) in soil of Varanasi district of Uttar Pradesh and Chaudhary *et al* (2007) in soil of Dhule district.

Out of 30 soil samples collected from 6 villages of Narayanpur block 4% soil samples were found medium and 96% were found in low range. Climate has a major impact on availability of nitrogen, maximum soil samples were found in low category it may be due to uncertain rainfall.

The available phosphorous content in these soils were varied from 15.37 to 38.62 kg ha^{-1} with a mean value of 27.51 kg ha^{-1}. The lowest (15.37 kg ha^{-1}) P content was observed in 7 Rajupur Village., while height (38.62 kg ha^{-1}) was recorded in village 1

Ghurahupur followed with S.D. value of 7.18 and C.V. value of 26.12%.

Out of 30 soil samples collected 43.33% soil samples were found medium, 46.66% soil samples found in high and 10% low P content. These finding are in agreement with the result reported by Singh *et al* (2016) in soil of Varanasi district of Uttar Pradesh and Meena *et al* (2006) in soil of Tonk district of Rajasthan.

The potassium content in these soils was ranged from 132.23 to 560.62 kg ha^{-1} with a mean value of 321.77 kg ha^{-1} K. The lowest value (132.23 kg ha^{-1}) of K was recorded in soils of Bangala while highest value (560.62 kg ha^{-1}) of K content was recorded in village Ghurahupur. With S.D. value 115.23 and C.V. value of 35.81%. Pulakeshi *et al*. (2011) observed that the similar result of soil in mantagani village of North Karnataka.

Out of 30 soil samples 62.66% soil samples were found medium, 33.34% soil samples were found high and 4% low K content. The higher value of K may be due to high use of potassic fertilizer.

Table 4.2.1: Status of available Primary macronutrients in soil

Soil characteristics	Range	Mean	S.D	C.V. (%)
Available N (kg ha^{-1})	132.72-280.37	184.73	36.69	19.86
Available P (kg ha^{-1})	15.37-38.62	27.51	7.18	26.12
Available K (kg ha^{-1})	132.23-560.62	321.77	115.23	35.81

Table 4.2.2: Classification and status of available N in soils of Narayanpur block

Available N (kg ha^{-1})	No. of samples	% of samples
Low (<280)	29	96.66
Medium (280-560)	1	3.34
High (>560)	0	0

(Source: Ramamoorthy and Bajaj, 1969)

Table 4.2.3: Classification and status of available P in soils of Narayanpur block

Available P (kg ha^{-1})	No. of samples	% of samples
Low (<12.5)	3	10
Medium (12.5-25)	13	43.33
High (>25)	14	46.66

(Source: Ramamoorthy and Bajaj, 1969)

Table 4.2.4: Classification and status of available K in soils of Narayanpur block

Available K (kg ha^{-1})	No. of samples	% of samples
Low (<135)	3	10
Medium (135-335)	17	56.66
High (>335)	10	33.33

(Source: Ramamoorthy and Bajaj, 1969)

4.3 Status of available secondary macronutrients viz. S, in soils

The data on status of available S in soils of Narayanpur block of Mirzapur district was presented in table 4.3 and Fig. No.4 its subparts. The available Sulphur content in soils of Narayanpur ranged from 10.44 to 39.68 kg ha^{-1} with an average value of 22.79 kg ha^{-1}. The lower (10.44 kg ha^{-1}) value of Sulphur was recorded in soil soils of Pahadi. (A) While higher value 39.68 kg ha^{-1} of S content was recorded in Ghurahupur villages with S.D. value of 7.28 and C.V. value 31.95%. These finding are conformation Singh and Mishra (2012) and Verma *et al.* (2005) on the available Sulphur in the soils of Varanasi district of Uttar Pradesh.

Out of total 30 soil samples 40% soils samples were found medium, 60% soils samples were found high in Sulphur content in soil of Narayanpur. Sulphur in these soils is due to use of Sulphur rich complex fertilizers.

Table 4.3.1: Status of available secondary macronutrients viz. S, in soils of Narayanpur block

Soil characteristics	Range	Mean	S.D	C.V. (%)
Available S (kg ha^{-1})	10.44-39.68	22.79	7.28	31.95

Table 4.3.2: Categorization of Sulphur content in soils of Narayanpur block

Available S (kg ha^{-1})	No. of samples	% of samples
Low (<10)	0	0.00
Medium (10-20)	12	40
High (>20)	18	60

(Source: Ramamoorthy and Bajaj, 1969)

Table 4.3.3: Correlation between physico- chemical properties and available nutrients in soil of Narayanpur block

	N	P	K	S
pH	0.137	0.142	0.008	-0.129
EC	0.477**	-0.322	0.024	-0.074
OC	-0.167	0.022	-0.099	-0.097
BD	0.293	-0.180	0.075	0.129
PD	0.350	0.135	-0.217	-0.029

**Correlation is significant at the 0.01 level

The data on correlation between soil properties and available nutrients in soil of Narayanpur block were presented in table 4.3. The soil pH (t=.137) was found positive correlation with available nitrogen. The close relationship between available nitrogen and organic carbon may be due to association of nitrogen with organic matter, adsorption of N with organic matter and adsorption of ammonical N by humus complex in soil. Similar relation was observed by Mathur *et al.* (2006) reported that the DTPA-extractable zinc was significantly and negatively correlated with pH (r = -0.383**), CaCO3 (r = -0.196*), and positively correlated with organic carbon (r = +0.738**). Organic carbon, bulk density, EC has not significant relationship with nitrogen. Particle density and water holding capacity showed negatively correlated with nitrogen.

Available phosphorus significantly correlated with organic carbon (r=0.288**) and water holding capacity (r=.022). EC (r=-322) and bulk density (r= .034) has negatively non-significant correlation with phosphorus. The relation between available P and C level could not exhibit the concurrent results. Jadav and Mishra (2012) have also reported the similar results in soil of Mewar region of Rajasthan, and Janjgir district of Chhattisgarh, respectively.

A significant and positive correlation (r=0.307**) was found between available K and organic carbon (Table 4.3). Similar relationship was also reported by Chauhan (2001) Significant positive correlation was also found between available potassium and clay content.

Available K show non-significant negative relationship with pH (r=.008), particle density (r=-.217) and non-significant relationship with EC, bulk density and water holding capacity.

Available sulphur in these soil show significant relationship with pH (r=-129). Sulphur in these soil show non-significant correlation with organic carbon (r=-.097), bulk density (r=0.129) water holding capacity (r=0.070) and negatively non-significant relationship with EC (r=-0.10) and particle density (r= -0.046). Find out similar results observed by Meena *et al.* (2006) positive correlation (r=0.051) of organic carbon and available sulphur.

4.4 Nutrient Index of soils of Narayanpur block

The nutrient index value of available macronutrient (N, P and K), available secondary nutrients (S,) and of Narayanpur block of Mirzapur district were given below in table 4.5.

The nutrient value index for soil of Narayanpur was Low for nitrogen and High for Phosphorus and Potassium, while High for Sulphur. The value worked out from nutrient index for Nitrogen, Phosphorus, Potassium and Sulphur are 1.04, 2.50, 2.29 and 2.62, respectively, against the nutrient index value <1.5 for low, 1.5 to 2.5 for medium and >2.5 for high fertility status of area (Kumar and Shekar 2013).

Table 4.4.1: Nutrient Index values of Narayanpur block of Mirzapur district

S. No.	Available Nutrient	NIV	Category
1	Nitrogen	1.04	Low
2	Phosphorus	2.50	High
3	Potassium	2.29	High
4	Sulphur	2.62	High

Fig. 4.1.1: Nutrient index of available N, P and K in soils

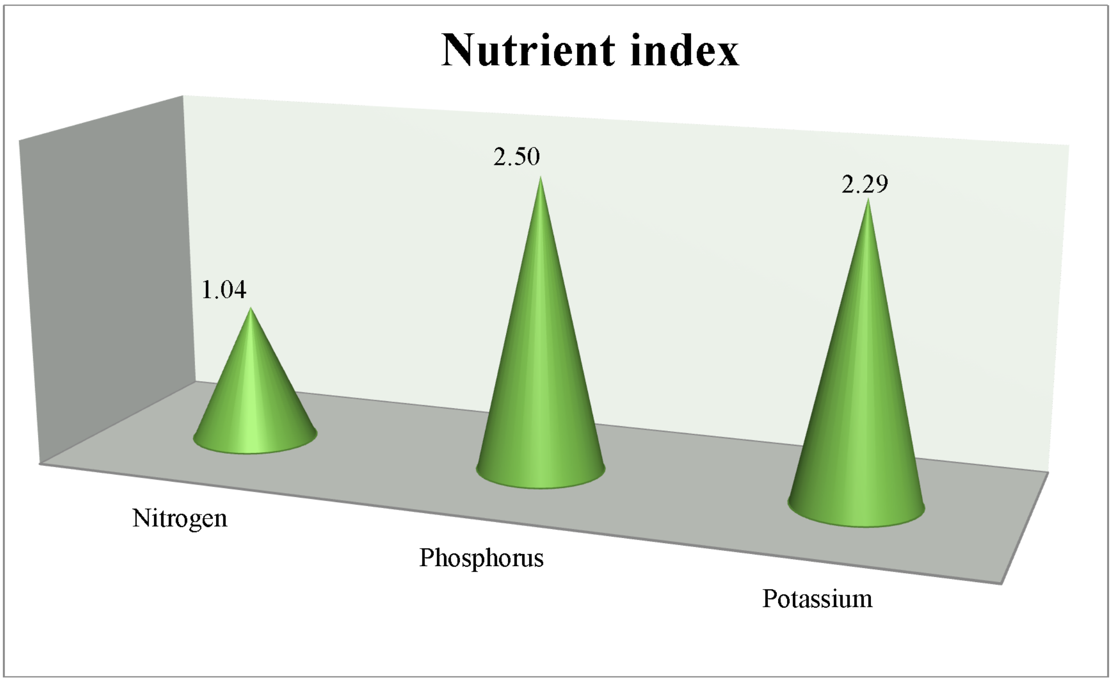
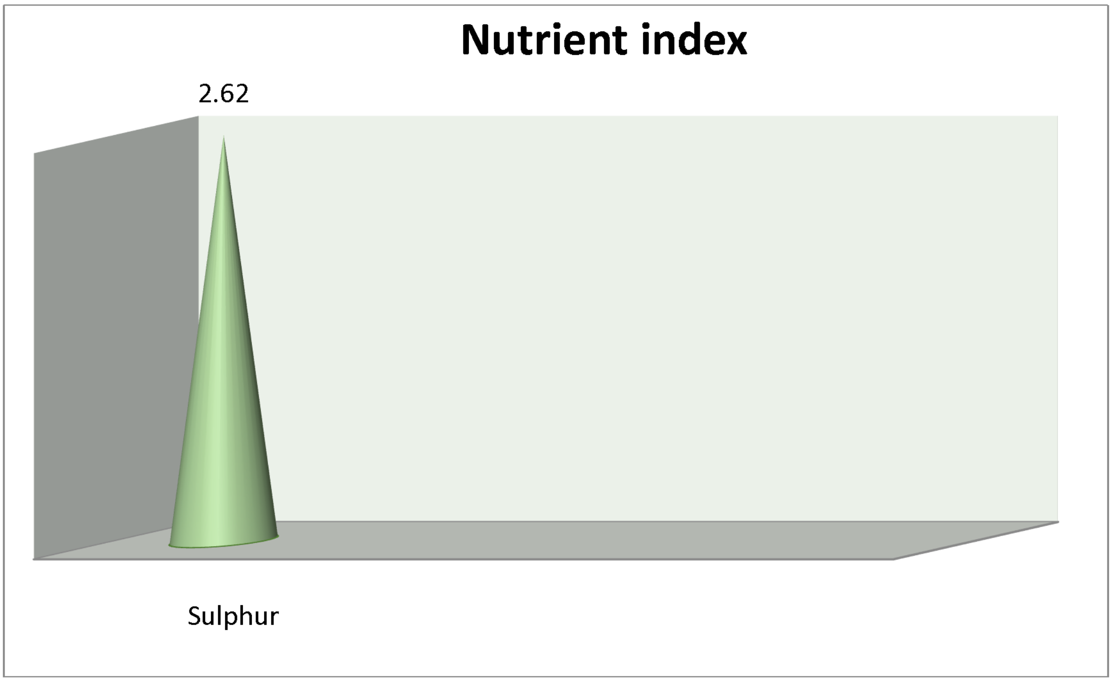


Fig. 4.1.2: Nutrient index of available S in soils



Chapter-V

SUMMARY AND CONCLUSION

The present investigation entitled **"Soil quality status of different villages in Narayanpur block of Mirzapur district, Uttar Pradesh"**. The study was carried out during summer season 2016 - 17. Soil samples were collected from (0-15 cm) from 6 villages of Narayanpur block. The collected soil samples were processed and analyzed for various physico-chemical properties and available nutrient in laboratory following standard procedures. An attempt was made to develop a soil fertility map of studied area, to study the correlation of relevant soil properties with relevant nutrients.

The salient findings of present investigation are summarized below:

- **Soil sample of Narayanpur block in Mirzapur district.**

1. The p^H of surface soils of farmer's field ranges from 6.8 to 8.1. Soil samples is generally neutral to moderately saline. Overall 33.33, 30 and 40.00% soil samples were neutral, moderately saline respectively.

2. The electrical conductivity of area under study ranges from 0.10 to 0.42 dS m^{-1} with a mean value of 0.22 dSm^{-1}. The investigation suggests that salt accumulation is not a problem in these soils for proper growth and development of crops.

3. Bulk density and Particle density of soil ranges from 1.10 to 1.38 Mg m^{-3} and 2.16 to 2.70 Mg m^{-3} and mean 1.28 Mg m^{-3} and 2.35 Mg m^{-3}, respectively.

4. Majority of samples were low in organic carbon. Organic carbon ranges from 0.24 to 0.84% with a mean of 0.49%, 50% and 36.66% soil samples are in low and medium range, respectively.

5. Available Nitrogen content in soil of farmer's field ranges from 132.72 to 280.37 kg ha^{-1} with a mean of 184.73 kg ha^{-1}. Overall assessment proved 96.66% soil sample were in low category, 3.34% present in medium category.

6. Available Phosphorus content in the soils of Narayanpur block ranges from 15.37 to 38.62 kg ha^{-1} with a mean of 27.51 kg ha^{-1}. Overall assessment proved 43.33% soil

sample were in medium ranges and 46.66% samples in high category, respectively.

7. Available Potassium content in the soils of Narayanpur block ranges from 132 to 560.62 kg ha^{-1} with a mean of 321.77 kg ha^{-1} Overall assessment proved 62.66% soil sample were in medium category, 33.34% samples were present in high range, respectively.

8. Available Sulphur content in the farmer's field of Narayanpur block ranges from 10.44 to 39.68 kg ha^{-1} with a mean of 22.79 kg ha^{-1} Overall assessment proved 40% soil sample were in medium category, while 60% samples were present high range, respectively.

9. The soil pH (t=0.137) was found positive correlation with available nitrogen. The close relationship between available nitrogen and organic carbon may be due to association of nitrogen with organic matter, adsorption of N with organic matter and adsorption of ammonical N by humus complex in soil.

Conclusion

From the present study, it can be concluded that the soils of Narayanpur block in Mirzapur district is categorized under neutral to moderately saline and alkaline in reaction. Organic carbon is medium to low in all the soils of studied area. Out of 30 soil samples 37% medium and 50% found low in organic carbon while, 13% high and 4 % found low in available nitrogen. In another hand, 44% soil sample found medium and 57% found medium in available phosphorus and potassium content in soil. Sulphur is found medium in 40% soil samples and also high in 60%. Organic carbon, bulk density, EC has not significant relationship with nitrogen. Particle density and water holding capacity showed negatively correlated with nitrogen.

Improper agriculture practices, intensive farming, monoculture type of cropping pattern and over irrigation are responsible for the deterioration of soil quality in the area. To overcome the adverse effect of these chemical cultivation efforts should be made to exploit all the available resource of nutrients under the theme of integrated nutrient management (INM). Under this approach the best available option lies in the complimentary use of bio fertilizers, organic manures in suitable combination of chemical fertilizers. ‘Organic agriculture’ system should be inoculated which begins to consider potential environmental and social impacts by eliminating the use of synthetic inputs such as synthetic fertilizers, pesticides etc. The camps, rallies and training programmers for the farmers should be arranged for increasing awareness regarding the benefits of organic agriculture, bio-fertilizers etc.s in crop production and thereby improving soil fertility and nutrients status.

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APPENDICES

Appendix-1: Status of available p^H, EC, BD and PD in soil.

Sample No.	pH	EC (dSm^{-1})	BD ($Mg\ m^{-3}$)	PD ($Mg\ m^{-3}$)
S1	7.6	0.32	1.31	2.38
S2	7.8	0.16	1.21	2.38
S3	7.4	0.36	1.23	2.34
S4	7.1	0.26	1.27	2.39
S5	8.0	0.12	1.33	2.51
S6	7.5	0.20	1.36	2.45
S7	8.2	0.15	1.34	2.33
S8	7.8	0.11	1.10	2.41
S9	7.4	0.25	1.33	2.23
S10	7.1	0.23	1.32	2.38
S11	8.8	0.21	1.25	2.32
S12	7.8	0.14	1.38	2.37
S13	8.1	0.32	1.18	2.39
S14	8.3	0.35	1.26	2.42
S15	7.2	0.12	1.21	2.27
S16	7.4	0.20	1.34	2.37
S17	7.7	0.15	1.37	2.70
S18	8.1	0.25	1.30	2.50
S19	8.3	0.10	1.25	2.17

Sample No.	pH	EC (dSm^{-1})	BD ($Mg\ m^{-3}$)	PD ($Mg\ m^{-3}$)
S20	7.6	0.17	1.24	2.16
S21	7.8	0.19	1.27	2.38
S22	7.1	0.18	1.22	2.28
S23	7.5	0.15	1.32	2.34
S24	8.0	0.34	1.34	2.43
S25	8.3	0.40	1.32	2.25
S26	7.9	0.42	1.31	2.28
S27	7.4	0.24	1.29	2.45
S28	6.8	0.18	1.20	2.27
S29	8.0	0.32	1.26	2.33
S30	7.4	0.26	1.37	2.24
Min.	6.8	0.10	1.10	2.16
Max.	8.8	0.42	1.38	2.70
Mean	7.71	0.22	1.28	2.35
S. D.	0.44	0.09	0.064	0.10
C. V.	5.58	40.90	5.03	4.54

Appendix-2: Status of available Organic carbon, Nitrogen, phosphorus Potassium and Sulphur in soil.

Sample No.	Organic Carbon (%)	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potassium (Kg ha^{-1})	Sulphur (Kg ha^{-1})
S1	0.30	176.63	38.58	350.00	27.38
S2	0.27	135.67	27.72	332.42	31.10
S3	0.46	153.23	30.78	298.65	20.23
S4	0.50	178.32	31.25	258.62	26.16
S5	0.37	265.42	24.82	300.82	18.62
S6	0.63	191.23	18.28	480.10	35.62
S7	0.47	175.61	15.37	342.35	31.00
S8	0.84	163.21	19.41	160.32	26.46
S9	0.50	153.23	26.72	220.00	28.28
S10	0.39	206.98	28.95	255.00	15.22
S11	0.36	265.82	20.45	385.45	11.65
S12	0.66	197.42	23.42	170.42	26.36
S13	0.84	153.95	32.84	213.80	28.65
S14	0.79	175.62	38.62	232.42	16.94
S15	0.36	155.32	28.34	240.71	22.60
S16	0.50	166.75	24.58	382.20	26.64
S17	0.57	197.42	37.10	290.00	15.82
S18	0.24	280.37	24.36	225.62	10.44
S19	0.36	156.33	20.58	542.18	27.56

Sample No.	Organic Carbon (%)	Nitrogen (Kg ha^{-1})	Phosphorus (Kg ha^{-1})	Potassium (Kg ha^{-1})	Sulphur (Kg ha^{-1})
S20	0.61	159.87	23.28	295.16	16.68
S21	0.29	185.58	33.15	355.23	27.83
S22	0.24	194.30	43.54	382.62	22.92
S23	0.64	148.15	39.67	482.40	21.37
S24	0.34	175.18	21.58	378.42	39.68
S25	0.76	225.78	27.85	420.84	13.20
S26	0.64	208.48	25.20	560.62	16.11
S27	0.38	182.32	19.35	280.18	18.60
S28	0.54	132.72	35.60	530.00	12.38
S29	0.62	222.64	25.82	154.32	18.10
S30	0.37	158.49	18.20	132.23	30.00
Min.	0.24	132.72	15.37	132.23	10.44
Max.	0.84	280.37	38.62	560.62	39.68
Mean	0.49	184.73	27.51	321.77	22.79
S. D.	0.17	36.69	7.18	115.23	7.28
C. V.	35.62	19.86	26.12	35.81	31.95

Appendix – 3: Characterization of physico-chemical properties in soils of Narayanpur block.

S.No.	Village.	pH				EC (dSm^{-1})				Organic Carbon (%)			
		Range	<	7.5-8.0	>	Range	<	0.8-2	>	Range	<	0.5-0.75	>
		(Mean)	7.0-7.4	Moderately Saline	8.0-8.8	(Mean)	0.8	Normal	2	(Mean)	0.5	Medium	0.75
			Neutral		Alkaline		Safe		Unsafe		Low		High
1	Ghurahpur	7.1-8.0 7.4	2	2	1	0.12-0.36 0.27	-	5	-	0.27-0.50 0.38	1	2	2
2	Rajupur	7.1-8.2 7.7	2	2	1	0.11-0.25 0.17	-	5	-	0.39-0.84 0.61	2	1	2
3	Kolana	7.2-8.8 8.2	2	2	1	0.12-0.35 0.25	-	5	-	0.36-0.84 0.66	2	2	1
4	Naharipur	7.4-8.3 7.8	2	2	1	0.10-0.25 .17	-	5	-	0.24-0.61 0.41	1	2	2
5	Pahadi	7.1-8.3 7.6	2	2	1	0.15-0.40 0.21	-	5	-	0.24-0.76 0.37	1	2	2
6	Bangala	7.4-8.0 7.5	2	2	1	0.18-0.42 0.29	-	5	-	0.38-0.64 0.54	1	1	3
Total		30	12	12	6	30		30		30	8	10	12
Percentage%													

Appendix – 4: Characterization of macronutrients (N, P and K) in soils

S.No.	Village	Nitrogen (N) kg ha^{-1}				Phosphorus (P) kg ha^{-1}				Potassium (K) kg ha^{-1}			
		Range	< 280	280-560	>560	Range	<12.5	12.5-25	>25	Range	<135	135-335	>335
		(Mean)	Low	Medium		(Mean)		Medium		(Mean)		Medium	
					High		Low		High		Low		High
1	Ghurahpur	135-265	5	-	-	24-38	-	1	4	258-300	-	5	-
		160				32				265			
2	Rajupur	153-206	5	-	-	15-28	-	3	2	234-243	-	5	-
		170				19				209			
3	Kolana	153-265	5	-	-	20-38	-	2	3	234-252	-	5	-
		198				28				231			
4	Naharipur	156-280	5	-	-	20-37	-	1	4	245-256	-	5	-
		200				26				234			
5	Pahadi	148-225	5	-	-	21-43	-	1	4	265-300	-	5	-
		175				34				231			
6	Bangala	132-222	5	-	-	18-35	-	3	2	213-560	-	4	1
		186				26				343			
Total		30	30			30	-	11	19	30	-	29	1
Percentage %			100										