

MINOR RESEARCH PROJECT IN PHYSICAL SCIENCE

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**Impact of Pesticides and Fertilizers on Quality of
Water in Wetlands (Kole) and Neighbouring Areas
of Division 43 of Thrissur Corporation**



Final Report by the Principal Investigator to the UGC

(June 2014 – March 2015)

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DECLARATION

I, Joseph. B.I, hereby declare that the minor research project, entitled, **“Impact of pesticides and fertilizers on quality of water in wetlands (Kole) and neighbouring areas of division 43 of Thrissur Corporation”** submitted to the University Grants Commission is a record of original and independent research done by me and it has not formed the basis for the award of any Degree/Diploma/Fellowship or other similar title to any candidate in any University.

Place: Elthuruth

Joseph.B.I.

Date: 30-March-2016

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I thank God Almighty by whose grace I have completed this work successfully.

B.I. Joseph

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CONTENTS

TITLE	PAGE No.
CHAPTER 1: INTRODUCTION	1
1.1 IMPORTANCE OF ASSESSING WATER QUALITY	2
1.2 AGRICULTURE AND THE ENVIRONMENT	3
1.3 REVIEW OF LITERATURE	3
1.4 SCOPE OF PRESENT WORK	5
1.5 OBJECTIVES OF STUDY	6
CHAPTER 2: EXPERIMENTAL	7
2.1 STUDY AREA	7
2.2 COLLECTION OF WATER SAMPLES	7
2.3 CHEMICAL ANALYSIS	7
2.3.1 pH DETERMINATION	7
2.3.2 FLUORIDE	8
2.3.3 CHLORIDE	8
2.3.4 PHOSPHATE	9
2.3.5 NITRATE	9
2.3.6 SULPHATE	10
2.3.7 AMMONIUM	10
2.3.8 IRON	10
2.3.9 CHROMIUM	11
2.3.10 DISSOLVED OXYGEN	11
2.3.11 CHEMICAL OXYGEN DEMAND	12
2.3.12 TOTAL HARDNESS	13
2.3.13 ELECTRICAL CONDUCTIVITY	13
2.3.14 PESTICIDE CONTENT	14
CHAPTER3:RESULTS AND DISCUSSIONS	15
3.1. ANALYSIS OF WATER SAMPLES AT THE FIELD OF STUDY AND FROM THE WELL AT 10m FROM THE KOLE WET LAND	15
3.1.1 pH VALUES	15
3.1.2. FLUORIDE	17
3.1.3 CHLORIDE	18
3.1.4 PHOSPHATE	18

3.1.5 NITRATE	19
3.1.6. SULPHATE	20
3.1.7. AMMONIUM	22
3.1.8. IRON	23
3.1.9 CHROMIUM	24
3.1.10. DISSOLVED OXYGEN (DO)	25
3.1.11. CHEMICAL OXYGEN DEMAND (COD)	25
3.1.12. TOTAL HARDNESS	26
3.1.13. CONDUCTIVITY	28
3.1.14. TOTAL DISSOLVED SOLIDS (TDS)	29
3.2 PESTICIDES	31
3.3 ANALYSIS OF WATER SAMPLES FROM WELLS AT DIFFERENT DISTANCES	32 33
CHAPTER 4: CONCLUSION	36
REFERENCES	38

LIST OF TABLES

Title	Page No.
3.1: Name of the samples	15
3.2: Pesticide analysis	33
3.3: The names of wells at different distances	34
3.4: Analysis of water from the wells at different distances from the Land	34

LIST OF FIGURES

Title	Page No.
3.1: pH variation of well water in different months	16
3.2: pH variation of field water in different months	16
3.3: Fluoride variations in Field water in different months	17
3.4: Variation of Chloride in ppm of well water in different months	18
3.5: Variation of Chloride in ppm of Field water in different months	19
3.6: Variation of Phosphate in ppm of Field water in different months	20
3.7: Variation of Nitrate in ppm of well water in different months	21
3.8: Variation of Nitrate in ppm of Field water in different months	21
3.9: Variation of Sulphate in ppm of well water in different months	22
3.10: Variation of Sulphate in ppm of Field water in different months	23
3.11: Variation of ammonium in ppm of Field water in different months	24
3.12: Variation of Iron in ppm of Field water in different months	24
3.13: Variation of DO in ppm of well water in different months	25
3.14: Variation of DO in ppm of Field water in different months	26

3.15: Variation of COD in ppm of well water in different months	27
3.16: Variation of COD in ppm of Field water in different months	27
3.17: Variation of Total Hardness in ppm of well water in different months	28
3.18: Variation of Total Hardness in ppm of Field water in different months	29
3.19: Variation of conductivity in μ /s of well water in different months	30
3.20: Variation of conductivity in μ S/cm of Field water in different months	30
3.21: Variation of TDS in mg/l of well water in different months	31
3.22: Variation of TDS in mg/l of Field water in different months	32

CHAPTER 1

INTRODUCTION

Water is the finest of all things, said the eminent Greek philosopher Pindar. Though these words uttered a half millennium ago, the significance of this statement is evident even now as we stepped in to 21st century. The availability of aquatic water in terms of both quality and quantity is essential for human existence. Earlier the importance of water was given only from the point of view of quantity. Historically civilization developed around water bodies was utilized to boost agriculture and transportation besides for human consumption. Earlier; humans could assess water quality only through the physical sense of sight, taste, and smell. Only after the development of biological, chemical and medical science, methods to measure the water quality and to determine its effects on human health were identified.

Water is the internal medium for almost all organisms and all the biochemical reactions in the body of the organisms is taking place in that medium. In the earth's crust only 0.01% of total water exists as surface fresh water. Surface water is usually rich in turbidity, suspended impurities of decaying organic matter, sand and finely divided clay, microorganism and bacteria and small amount of mineral salts dissolved from top soil.

During recent years there has been arising awareness and concern about water pollution all over the world and new approach towards fulfilling sustainable exploitation of water resources have been developed international. Control of water pollution has gained primary importance in developed and a number of developing countries. It has become a point of critical concern in large number of industrialized countries in setting limits for the discharge of hazardous substance with the best available technology.

A huge amount of water is wasted in agriculture, industry and urban areas. It has been assessed that with available technologies and better operational practices, agricultural water demand could be cut by about 50% and that in urban areas by about 33% without disturbing the quality and economics

of life. But most government does not have passable laws or regulations to protect their water system.

The environment impact of pesticides consists of the effects of pesticides on non-target species. Over 98% of sprayed insecticides and 95% of herbicides reach a terminus other than their target species, because they are sprayed or spread across entire agricultural field. Run off can carry pesticides in to aquatic environments while wind can carry them to other fields, grazing areas, human settlement and undeveloped areas, possibly affecting other species. Other problems emerge from poor production, transport and storage practices. Over time frequent application increases pest resistance while its effects on other species can facilitate the pest's resurgence. Each pesticides or pesticides class comes with a specific set of environmental angles. Such adverse effects have led many pesticides to be banned while regulation have limited and reduced the use of others.

Over time pesticides have generally become less persistent and more species specific, reducing their environmental footprint. In addition, the amount of pesticides applied per hectare has declined in some cases by 99%. However the global spread of pesticides use, including the use of older or out-dated pesticides that have been banned in some jurisdictions has increased overall.

1.1 IMPORTANCE OF ASSESSING WATER QUALITY

Water is generally a renewable resource. However the natural supply of water in hard rock is limited in time and space. Further the quality of available fresh water resources is under severe threat. One of the most important issues in the water management is extending minimum adverse effect to the environment while exploiting it for the maximum economic benefits. All over the world, regions that have sustainable ground water balance are shrinking day by day. There are three problems which govern water use, depletion due to overdraft, water logging due to mostly poor drainage and insufficient conjugative use and pollution due to agricultural, industrial and other human activities. Practically natural quality of water depends upon the physical environment and the origin of water. As the water move through the hydrological cycle, various chemical physical and biological processes change its original quality through the reaction with soil, rocks and organic matter. Natural processes and human activities cause changes in water quality directly or indirectly.

Nitrate is a problem as a pollutant in drinking water (primarily from groundwater and wells) due to its harmful biological effects. High concentrations can cause Methemoglobinemia and have been cited as a risk factor in developing gastric and intestinal cancer. Due to these health risks, a great deal of emphasis has been placed on finding good treatment processes to decrease nitrate concentrations to harmless levels. An even more important aspect to reduce the problem is prevention measures to stop the leaching of nitrate from the soil.

So quality assessment and management are to be carried out hand in hand to have a pollution free environment for the future. Hence in order to assess the quality of water for its utilisation by human beings and for its use in agriculture, it becomes necessary to understand the chemical quality of water by estimating different relevant constituents.

1.2 AGRICULTURE AND THE ENVIRONMENT

The arrival of humans in an area, to live or to conduct agriculture necessarily has environmental impact. These range from simple crowding out of wild plants in favour of more desirable cultivars to large scale impacts such as reducing biodiversity by reducing food availability of native species, which can propagate across food chain. The use of agricultural chemicals such as fertilizers and pesticides magnify those impacts, while advances in agro chemistry have reduced those impacts (for example by the replacement of long lives chemicals with those that reliably degrade) even in the best case they remain significant. These effects are boosted by the use of older chemistries and poor management practices.

1.3 REVIEW OF LITERATURE

Fertilizers and pesticides are among the many wide spread storm water pollutant that can worsen water quality. Though fertilizers contain chemicals that are good for lawns and plants when used properly, too much amounts applied to lawns and gardens wash off and contaminate streams.

In the United States pesticides were found to pollute every stream and over 90% of wells sampled in study by the US geological survey. Pesticides remainders have also been found in rain and ground water. Pesticides impacts

on aquatic systems are often examined using a hydrology transport model to study movement and outcome of chemicals in rivers and streams.

There are 4 major routes through which pesticides reach the water. It may drift outside of intended area when it is sprayed, it may percolate or leach, through the soil, it may be carried to water as runoff, or it may be spilled. Factors that affect a pesticides ability to contaminate water includes its water solubility, the distance from an application site to a body of water, weather, soil type, presence of a growing crop and the method used to apply the chemical. Maximum limits of allowable concentration for individual pesticides in public bodies of water are set by the environmental protection agency in US.

The paddy fields of Kerala have been gradually polluted by the use of pesticides and fertilizers used in the agriculture. Hazardous pollutants like phosphates, sulphides, ammonia, fluorides and heavy metals enter into fields by the use of pesticides and fertilizers.

The literature describes that pollutant from the paddy fields will enter into the nearby wells and will lead to serious health hazards. Nitrate and phosphate pollution has been reported as a major problem in agricultural ecosystems, especially under intensive use of nitrogen and phosphorous fertilizers. The water pollution of the wells close to paddy fields due to hazardous heavy metals has been a major concern for environmentalists, as they are non-degradable and thus persistent. The presence of heavy metals in water has provoked much attention in the recent decades, because of their potential mutagenicity, carcinogenicity and toxicity. Moreover, they lead to undesirable effects in colour, odour and the taste of drinking water. Some pesticides do not decompose easily and can remain in the groundwater for a long period of time. Both short-term and long-term health hazards have reported from exposure to high levels of pesticides, particularly in individuals who work directly with pesticides, such as farmers and in people who live nearby the fields. The levels of pesticides and fertilizers normally found in drinking water is usually quite low and would not be likely to cause immediate health problems. However, exposure to small amounts of pollutants in drinking water over a long period of time cause severe health effects.

1.4 SCOPE OF WORK

As cited earlier water is the most precious gift of nature. All around the world various studies point towards water pollutant from unplanned use of pesticides and fertilizers in agriculture. This scenario induced us to study water pollution near the vicinity of Kole Wet Lands. There is an urgent need to reduce the water pollution around agricultural lands. Our study is an approach to understand the impact of fertilizers and pesticides on quality of groundwater in areas of division 43 of Thrissur Corporation.

Thrissur is one of the thickly populated districts in Kerala. Elthuruth a place near to Thrissur town. Wetland site is in the corporation area of Thrissur. The Hindu reported that many coastal areas of Thrissur district is reeling under a severe drought like situation. The costal belt is most affected and depletion of ground water leads to salt water intrusion. Times of India reported a study that has found alarming presence of coliform bacteria in the water resources of Thrissur. The improper land use management and waste management practices make the ground water polluted. The increased use of pesticides and fertilizers in agriculture, dumping of waste near road sides, flood due to heavy rain, improper waste management in hospital, markets, flats etc. increases pollution of ground water. An assessment of the situation is very important to take vigilance and protect aquifer system from contamination by the use of pesticides and fertilizers.

OBJECTIVES OF STUDY

The objectives of the study are

- To assess the effects of chemical fertilizers and pesticides on water quality in the selected agricultural area of division 43 of Thrissur Corporation.
- To evaluate the water quality parameters of groundwater near the agricultural area
- Suitability of well water for drinking purpose.
- To delineate the nitrate, fluoride, heavy metal contaminated area in division 43 of Thrissur Corporation.

CHAPTER 2

EXPERIMENTAL

2.1 STUDY AREA

Agriculture is one of the major occupations in Division 43 of Thrissur Municipal Corporation with paddy as major cultivable crop. The town geographically lies between 76.195367 °E Latitude and 10.5135782 °N longitude. The commonly used chemical fertilizers in the study area are Urea, Diammonium Phosphate or superphosphate, muriate of potash or NPK mixture, In addition to this, farmyard manures are also used. The pesticides used are Benzene Hexa Chloride, Malathion, Ecalux (Quinalphose) and Monocrotophose (now not used).The average annual application rate of nitrogenous and phosphorous fertilizers is over 200-250 kg/ha of urea and 150-200 kg/ha of Diammonium phosphate and 60 kg/ha of muriate of potash per cropping season, particularly in paddy cultivations. The soil type, which is predominant in the study area are clay soil.

2.2 COLLECTION OF WATER SAMPLES

Water samples were collected from selected agricultural lands and wells of division 43 of Thrissur Corporation. Pre-sterilized plastic containers were used for the collection of water samples. For studying the effect of pesticides and fertilizers on the Kole wet land, water samples from the field were collected during each month from December 2014 to September 2015. For the second study, water samples from a well at a distance of 10m from the kole wet land were collected during the same time period. The water from wells at different distances from the paddy field were also collected in the same period (December 2014 to September 2015) for studying the effect of pesticides and fertilizers on drinking water at different distances.

2.3 CHEMICAL ANALYSIS

2.3.1 DETERMINATION OF pH

pH is a numeric scale used to identify the acidity or basicity (alkalinity) of an aqueous solution. pH is the measure of the hydrogen ion concentration of a solution. The pH of water determines the solubility and biological availability

of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). Lower pH levels increase the risk of activated toxic metals that can be absorbed, even by humans, and levels above 8.0 cannot be effectively disinfected with chlorine, causing other indirect threats. Metals tend to be more lethal at lower pH because they are more soluble. The permissible limit of pH is 6.5 to 8.5 for drinking water according to the Drinking water Standards of WHO (2008). The pH of water is measured with the help of a digital pH meter (335 model, Systronics, India). pH meter was calibrated using ampoules of pH 4, 7 and 9 according to the manufacturer's instructions.

2.3.2 FLUORIDE

More than 70 years of scientific research has steadily shown that an optimum level of Fluoride in community water is safe and effective in preventing tooth decay by at least 25% in both children and adults. Excessive fluoride concentrations have been reported in ground waters of more than 20 developed and developing countries including India. In India 19 states are facing severe fluorosis problems. Fluoride level of 1ppm efficiently prevents dental problems without adverse effects on health.

Fluoride reagent (F1) obtained from the water testing kit manufactured by Nice, Chemicals, Pvt. Ltd. Edapilly, Kochi, Kerala used for the fluoride estimation. Take 5ml of water sample in a test tube and add 5 drops of Fluoride reagent-1 (after shaking well). Mix the contents very well. The colour that forms is compared with the Fluoride colour chart (obtained from Nice) and recorded as the Fluoride value.

2.3.3. CHLORIDE

Chloride is a major ion in surface water and waste waters and its concentration in natural waters alter widely. Chloride in drinking water is quite harmless, if present in amount below 250ppm. In waste water, the chloride content is greater than in raw water. High chloride content in water bodies harms metallic pipes and structures as well as agricultural crops.

Chloride reagent 1 (Cl-1) and Chloride reagent 2 (Cl-2) obtained from the water testing kit manufactured by Nice, Chemicals, Pvt. Ltd. Edapilly, Kochi, Kerala are used for the Chloride estimation. Take 25ml of water sample in the test bottle (no.1) and Add 5 drops of Chloride reagent-1(Cl-1) and mix well until a distinct yellow colour develops. Then add Chloride reagent 2 (Cl-2) to

the mixture and shake well after each drop until the yellow colour changes from yellow to red. Count the number of Chloride reagent (Cl-2) required for colour change. Then the presence of chloride can be calculated as

$$\text{Chloride (as Cl) in mg/l} = \text{Number of drops} \times 10$$

2.3.4 PHOSPHATE

Phosphate occurs in natural and waste water as inorganic and organically bound phosphate. Phosphate is mostly used for laundry purposes, treatment of boiler water and agriculture. The run off from all these sources finds their way in to water bodies. High concentration of phosphates in water bodies is an indication of pollution.

Phosphate reagent -1 (PR-1) and Phosphate reagent -2 (PR-2) obtained from the water testing kit manufactured by Nice, Chemicals, Pvt. Ltd. Edapilly, Kochi, Kerala are used for the Phosphate estimation. Take 5ml of water sample in the test tube. Add 5 drops of Phosphate reagent -1 (PR-1) and one drop of Phosphate reagent -2 (PR-2) and mix the contents and wait for 2-3 minutes for colour to develop. The colour that forms is compared with phosphate colour chart and record as the phosphate value

2.3.5. NITRATE

Nitrate is the highest oxidized form of nitrogen and its main source in water is biological oxidation of nitrogenous organic matter of both autochthonous and allochthonous origin. Domestic sewage and agricultural run-off are the chief sources of allochthonous nitrogenous organic matter. Dead organisms and metabolic wastes of aquatic communities form the autochthonous nitrogenous organic matter.

Nitrate reagent-1(NA-1) and nitrate reagent 2(NA-2) obtained from the water testing kit manufactured by Nice, Chemicals, Pvt. Ltd. Edapilly, Kochi, Kerala are used for the Nitrate estimation. Take 10ml of water sample in a test tube. Add a pinch of nitrate reagent-1(NA-1) and agitate the solution for 5 minutes. Allow to stand for a few minutes and decant the supernatant solution (about 5ml) to another test tube. Again add 3 drops of nitrate reagent 2(NA-2) to the supernatant solution and mix well. Wait for 5 minutes with occasional shaking. The final colour that forms is compared with nitrate colour chart and record the nitrate value.

2.3.6 SULPHATE – GRAVIMETRIC METHOD

All natural water contain appreciable amount of sulphates. These are particularly high in arid and semiarid regions where natural waters in general have high salt content. Sulphates are generally soluble in water and impart hardness to water. Sulphate is precipitated as barium sulphate in presence of HCl , the precipitate is washed till free from chloride, ignited and weighed as barium sulphate.

50ml of the sample is acidified with dil. HCl (2N HCl). 10ml of barium chloride solution (5%) is added and heated to boil. It was filtered through Whatman No 40 filter paper and continued the filtration by adding hot water till free from chloride. The filter paper dried and ignited in the muffle furnace at about 80⁰ C. Residue was cooled by keeping in a Desiccator and weighed as barium sulphate.

2.3.7 AMMONIUM

It is naturally present in surface water, ground water and domestic sewage. It is produced largely by the deamination of organic nitrogen containing compounds and hydrolysis of urea. In water bodies, it is formed naturally by the reduction of nitrates under anaerobic conditions.

Ammonium Reagent-1(NH-1) obtained from the water testing kit manufactured by Nice, Chemicals, Pvt. Ltd. Edapilly, Kochi, Kerala, used for Ammonium estimation. Take 5ml of water sample in the test tube and add 5 drops of Ammonium Reagent-1(NH-1) and mix well. The colour that forms is compared with ammonium colour chart immediately and record as the ammonium value

2.3.8. IRON

The common sources of iron in groundwater are naturally occurring, for example from weathering of iron bearing minerals and rocks, Industrial effluent, acid – mine drainage, sewage and landfill leachate may also contribute iron to local groundwater. Iron can collect and block pipes or fittings and produce colour, taste and rust flakes in water. Both substances can multiply the growth of unwanted bacteria that form a slimy coating in water pipes. The concentration of iron in well water can fluctuate seasonally and vary with depth and location of the well and geology of an area. Iron naturally occur in groundwater that has little or no oxygen, typically in deeper wells (but not

always), in areas where groundwater flow is slow, and in areas where groundwater flows through soils rich in organic matter. Concentrations that exceed the drinking water guideline can occur locally anywhere in the area.

Iron Reagent - 1(Fe-1) and Iron Reagent - 2(Fe-2) obtained from the water testing kit manufactured by Nice, Chemicals, Pvt. Ltd. Edapilly, Kochi, Kerala are used for the fluoride estimation. Take 5ml of water sample in the test tube and add 5 drops of Iron Reagent 1(Fe-1) and 1 drop of Iron Reagent 2 (Fe-2). Mix the contents and wait 2-3 minutes for colour to develop. The colour that forms is compared with iron colour chart and record as the iron value.

2.3.9. CHROMIUM

Chromium salts are used in industrial processes and laboratories and enter water bodies through discharge of waters. The normal level of Cr (VI) in drinking water is 3-40 ppb, the permissible limit level being 50ppb.

Reagents required for the analysis are con.HNO₃, 30% H₂O₂, con.H₂SO₄, NH₄OH, Methyl orange, 4%KMnO₄, 0.5% sodium azide, Phosphoric acid, and 0.5% of diphenyl carbazide in acetone.

50ml of water sample is taken in a conical flask. 5ml con. HNO₃, 2ml 30% H₂O₂ are added and evaporated on a water bath. 5ml Con. HNO₃ and 10ml con.H₂SO₄ are added and again evaporated. Diluted with distilled water, heated to boiling and filtered through sintered glass crucible. The filtrate and washings are made up to 100ml. 25ml of the above solution is taken in a conical flask, neutralised with strong ammonia solution in the presence of methyl orange indicator. The solution is acidified with con.H₂SO₄. 4%KMnO₄ solution is then added till dark red colour persists and boiled for two minutes. To the above solution 2ml 0.5% sodium azide is added and boiled till the colour fades. The solution is cooled and a little (0.25ml) of phosphoric acid is added. The solution is transferred to a 100ml volumetric flask, diluted and mixed. 2ml of diphenyl carbazide solution is added and mixed thoroughly. Mixture is allowed to stand for 10 minutes and absorbance measured at 540nm against a reagent blank prepared through the same procedure.

2.3.10 DISSOLVED OXYGEN

A dissolved oxygen level in natural and waste water depends upon the physical, chemical and bio-chemical activities in the water body. The analysis for DO is a key test in water pollution studies. The solubility of atmospheric oxygen in fresh water ranges from 14.621mg/l at 20°C to 6.950 mg/l at 35°C

under a unit atmospheric pressure. Underground water is scarce of DO with the dissolved mineral salts. Presence of organic matter decreases DO value because of the possible aerobic degradation. For drinking water the permissible limit for DO is found as 4ppm in ISI.

Dissolved oxygen reagent 1(DO-1), Dissolved oxygen reagent 2(DO2), Dissolved oxygen reagent 3(DO3), Dissolved oxygen reagent 4(DO-4), and Dissolved oxygen reagent 5(DO-5) obtained from the water testing kit manufactured by Nice Chemicals, Pvt. Ltd. Edapilly, Kochi, Kerala are used for the dissolved oxygen estimation.

Take 300ml of water sample in the test bottle (NO.1) and add 2ml of Dissolved oxygen reagent 1(DO-1) very carefully and tip of the filler is dipped well below the water level. Then add 2ml of dissolved oxygen reagent 2 very carefully and tip of the filler is dipped well below the water level. Replace the stopper without inclusion any air bubble and thoroughly mix the content by shaking the test bottle (no.1) several times and allow the precipitate formed to settle. After 2-3 minutes of settling, carefully remove the stopper of the test bottle (No.1) and immediately add 2ml of Dissolved oxygen reagent 3 (DO3) very carefully by running the reagent down the neck of the bottle and mix thoroughly to dissolve the precipitate settled completely. Take 200ml of the solution in an iodine flask (no.2) and add 4 drops of dissolved oxygen reagent 4 (DO-4) Titrate with Dissolved oxygen reagent 5(DD-5) taken in a 10ml syringe until the colour changes from blue to colourless.

$$\text{Dissolved oxygen in mg/l} = \text{Volume in ml of dissolved oxygen reagent 5 used for titration}$$

2.3.11 CHEMICAL OXYGEN DEMAND (COD)

This is a satisfactory method for determining the organic load of a water body. The COD values are of great importance, where BOD cannot pre-determined accurately due to the presence of toxic and other such favourable conditions for growth of microorganisms.

Reagents used for the COD are potassium dichromate (0.25N), Standard ferrous ammonium sulphate (0.25N), Ferroin indicator, Mercuric sulphate, Silver sulphate, and con. sulphuric acid.

Take 50.0 mL of sample in a reflux flask and diluted to 50.0 mL and then add 1 g of HgSO₄. To this mixture add 5.0 mL conc. H₂SO₄ and swirl until the mercuric sulfate has dissolved. Place the reflux flask in an ice bath and slowly add, with swirling, 25.0 mL of 0.025 N K₂Cr₂O₇. Then add 70 mL of sulfuric

acid-silver sulfate solution in to the cooled reflux flask. The flask is then reflux for 2 hours. Allow the flask to cool and wash down the condenser with about 25 mL of distilled water. Dilute the acid solution to about 300 mL with distilled water and allow the solution to cool to room temperature. Add 10 drops of ferroin indicator to the solution and titrate the excess dichromate with 0.25 N ferrous ammonium sulfate solution to the end point. At the end point color change from a blue-green to a reddish shade.

2.3.12. TOTAL HARDNESS

Hardness is a vital parameter in assessing the suitability of water for domestic and industrial purpose. The hardness is defined as the sum of Ca ion and Mg ion concentrations expressed as calcium carbonate in mg/l or ppm. There are two types of hardness, Permanent hardness and Temporary hardness. Temporary hardness is due to the presence of carbonates, bicarbonates of calcium and magnesium. Permanent hardness is due to presence of sulphates and chlorides of calcium and magnesium.

Hardness of the water samples were determined by EDTA titrimetric method. 50 ml of sample was taken in a conical flask. 1 ml buffer and 0.2 g EBT were added. This solution was titrated against the standard EDTA solution (0.01 M). The duration of titration was maintained to be within 5 minutes from the time of buffer addition. Standard EDTA of 0.01 M was added slowly with continuous stirring until the last tinge disappears from the solution. The solution turned blue at the end point.

Reagents used for the analysis are the following.

- 1) Standard EDTA solution (0.01 M): 1 ml equivalent of 1 mg of CaCO_3 . 3.723 gm. of EDTA was weighed and dissolved in 1 liter distilled water.
- 2) Ammonia Buffer: 16.9 gm of NH_4Cl in 143 ml concentrated NH_4OH was diluted to 250 ml with distilled water.
- 3) Erichrome Black T indicator (EBT) : 0.05 gm. EBT in 100 gm NaCl in 20 ml of water by warming

2.3.13 ELECTRICAL CONDUCTIVITY

Electrical conductivity (EC), also called specific conductivity, is a measure of the ability of water sample to convey an electrical current and it is related to the concentration of ionized substances in water. Ions that have a major influence on the conductivity of water are H^+ , Na^+ , K^+ , Mg^{2+} , Cl^- , SO_4^{2-} , and HCO_3^- etc.

It is an important measurement in water destined for various uses: irrigation, drinking, food industry and industrial boilers. The EC is measured directly with the help of conductivity meter.

The cell was rinsed with one or more portions of the sample to be tested and the conductivity was measured directly and reported as micro mhos/ at 30°C.

2.3.14 PESTICIDES

Pesticides contents were analysed in Nawal analytical laboratories (an ISO 9001- 2008, OSHAS 18001:2007, BIS recognized Lab) because of the absence of facilities in our laboratory. The samples were analysed according to Test protocol USEPA 525.2 (United States Environmental Protection Agency). Liquid solid extraction and capillary column gas chromatography/mass spectrometry were used for the analysis.

CHAPTER 3

RESULTS AND DISCUSSIONS

3.1 ANALYSIS OF WATER SAMPLES AT THE FIELD OF STUDY AND FROM THE WELL AT 10m FROM THE KOLE WET LAND

Water samples from the Kole wet land (field of study) and from the well at a distance of 10m from the Kole wet land were collected for a period 10 months from December 2014 to September 2015. Parameters such as pH values, fluoride concentration, chloride concentration, phosphate concentration, nitrate concentration, sulphate concentration, ammonium concentration, iron concentration, dissolved oxygen, chemical oxygen demand, total hardness, conductivity, total dissolved oxygen and pesticide concentration were measured as per the procedure given in Chapter 2. Name of the samples collected at different months are given in Table 3.1.

Table 3.1: Name of the samples

SI No.	Month	Sample name	
		Well sample	Field sample
1	December	WW1	FW1
2	January	WW2	FW2
3	February	WW3	FW3
4	March	WW4	FW4
5	April	WW5	FW5
6	May	WW6	FW6
7	June	WW7	FW7
8	July	WW8	FW8
9	August	WW9	FW9
10	September	WW10	FW10

3.1.1 pH VALUES

pH is the measure of acidity or alkalinity of water. The pH variations of well water at different months are given in Figure 3.1.

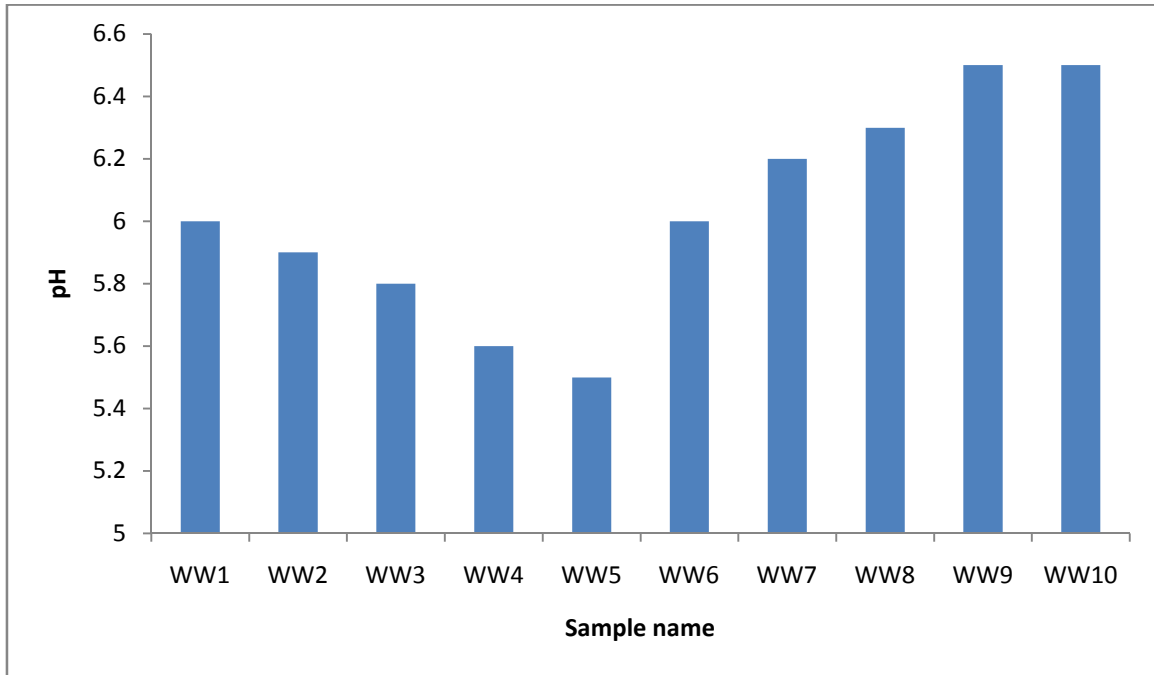


Figure 3.1: pH variation of well water in different months

pH value measurements showed that during the period of analysis pH is slightly acidic and the values diverge from 5.5 to 6.5. Higher pH value of 6.5 observed for the samples WW9 & WW10 whereas lower values observed for samples WW4 & WW5. The normal range for groundwater systems ranges from 6 to 8.5. Lower values observed for samples WW3, WW4 & WW5 may be due to the decrease in volume of water in summer.

The pH variations of field water are given in Figure 3.2

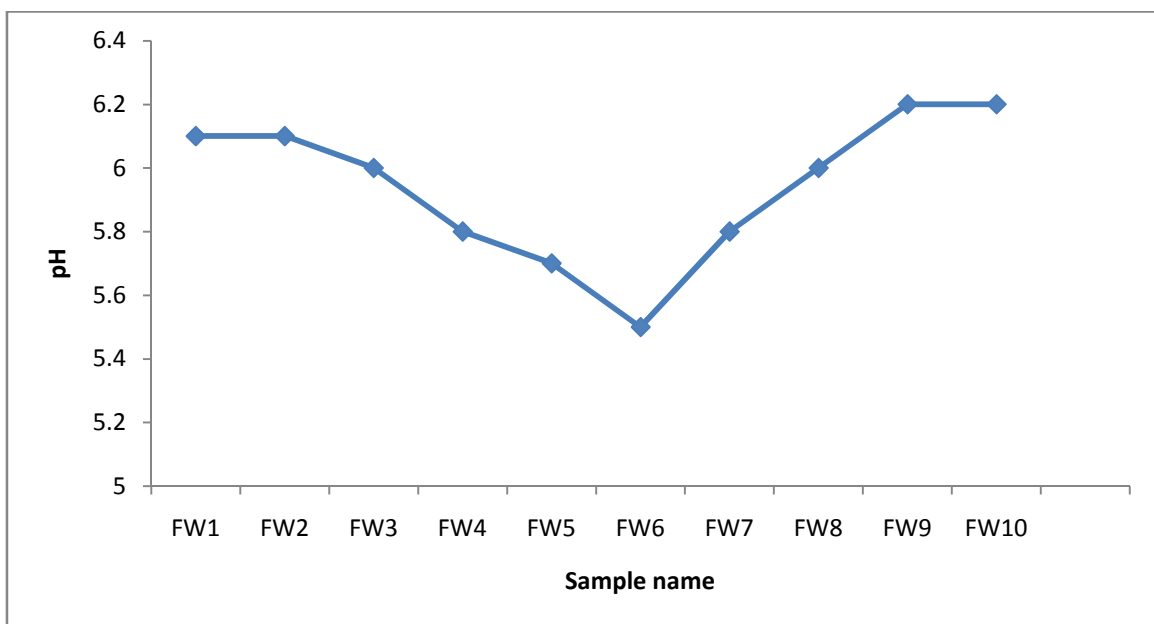


Figure 3.2: pH variation of field water in different months

pH values at the field of investigation during the period of analysis diverge from 5.6 to 6. Higher pH values are observed for the samples FW1, FW2, FW9 & FW10. The normal range pH in surface systems ranges from 6.5 to 8.5. pH values of field water is slightly lesser (1 to 0.5) than the normal range. This may be due to decrease in volume of water in summer.

During the present study, pH of water samples ranged from a minimum of 5.5 to a maximum of 6.5. The pH values noticed for some samples were slightly less than the permissible limits of Indian standards. When pure water is exposed to air, it becomes mildly acidic. This is because water absorbs carbon dioxide from the air, which is then slowly converted into bicarbonate and hydrogen ions (essentially creating carbonic acid). This may be the reason for acidity of well water.

3.1.2. FLUORIDE

Fluoride analysis of water samples in nearby well showed that the fluoride ion concentration was completely absent. This shows that well water is not contaminated by fluoride from the field water.

The variation fluoride concentration of Field water in different months is given in Figure 3.3.

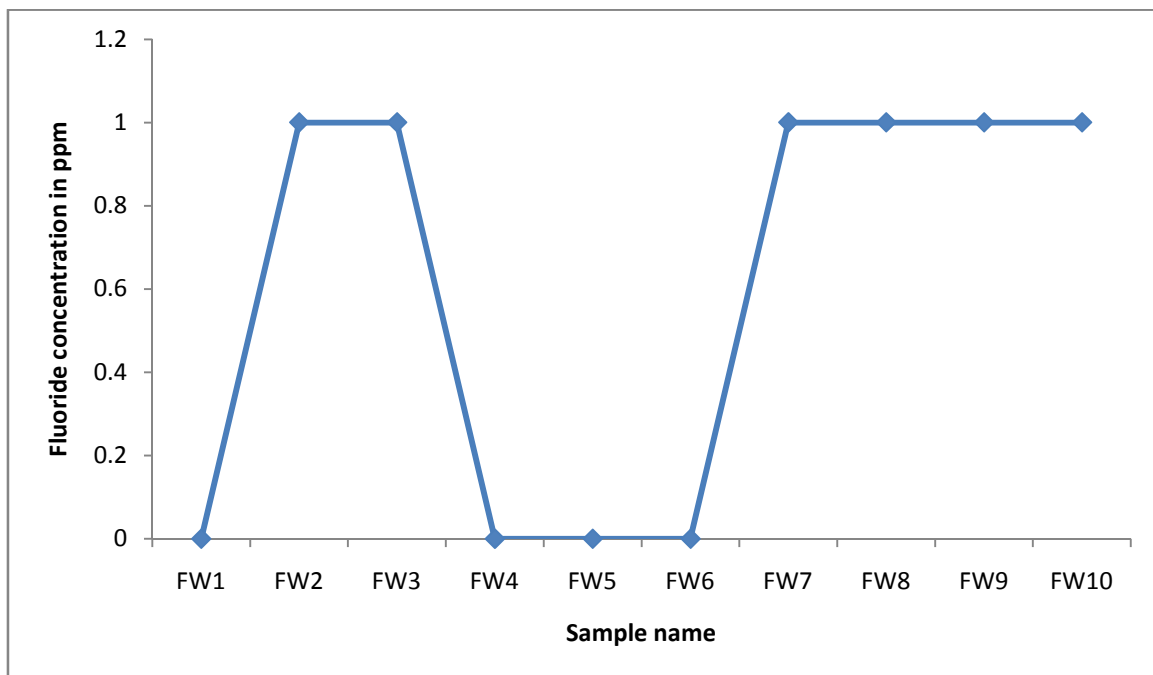


Figure 3.3: Fluoride variations in Field water in different months

Analysis showed that the fluoride ion concentration ranges from 0ppm to 1ppm in the field water. The maximum permissible limit of fluoride ion concentration for drinking water is 0.7ppm to 4ppm (WHO - 1983). Analysis showed that fluoride ion concentration of all samples are within the permissible limit.

3.1.3 CHLORIDE

Chloride ion occurs naturally in all types of water samples. Chloride in natural water results from agricultural activities or sometimes, it could be due to dissolution of chloride from chloride containing rocks. Presence of chloride in drinking water is not a health hazard. With the possible exception of coastal areas, level of chloride content in natural water is generally low. High concentration of chloride may impart a salty taste to water indicating chloride.

The variation of chloride concentration of well water in different months is given in Figure 3.4.

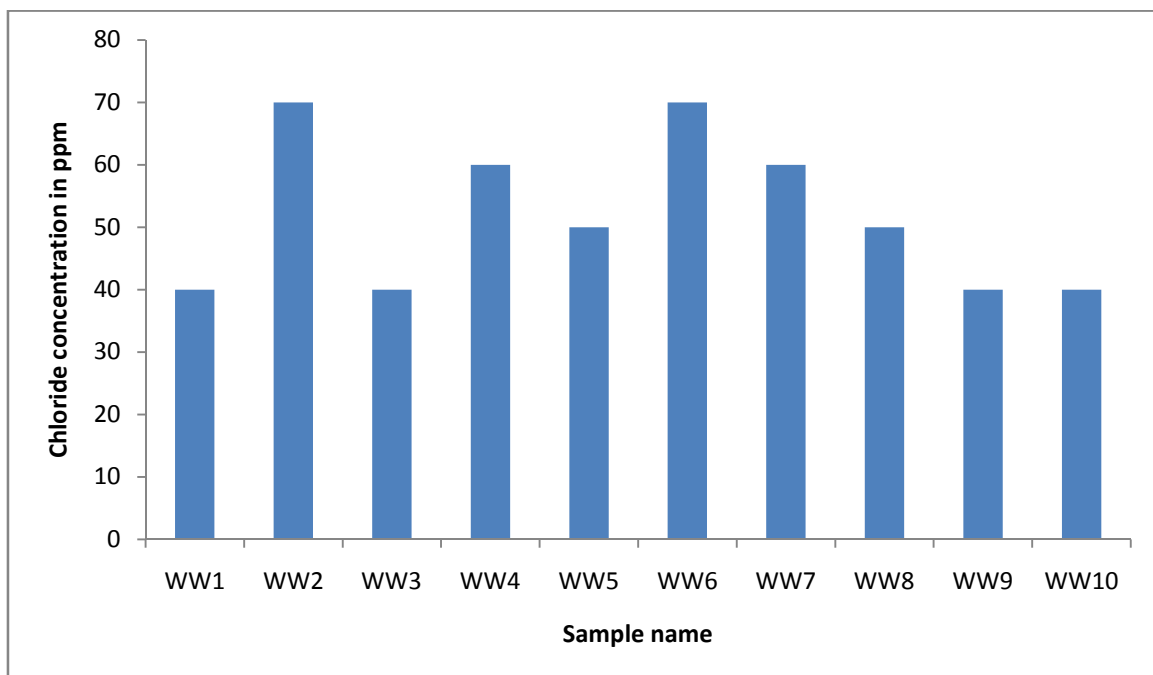


Figure 3.4: Variation of Chloride in ppm of well water in different months

Out of the ten samples, the highest chloride amount (70ppm) was seen in the samples WW2 & WW6. Lowest chloride ion concentration found during the samples WW1, WW3, WW9 & WW10 months. The sudden increase of chloride ion concentration in WW2 & WW6 may be due to the local contamination. The

maximum permissible limit of Chloride for drinking water is 300ppm by WHO (1983). Hence we can conclude that the well water samples are safe to drink.

The variation chloride of Field water in different months are given in Figure 3.5.

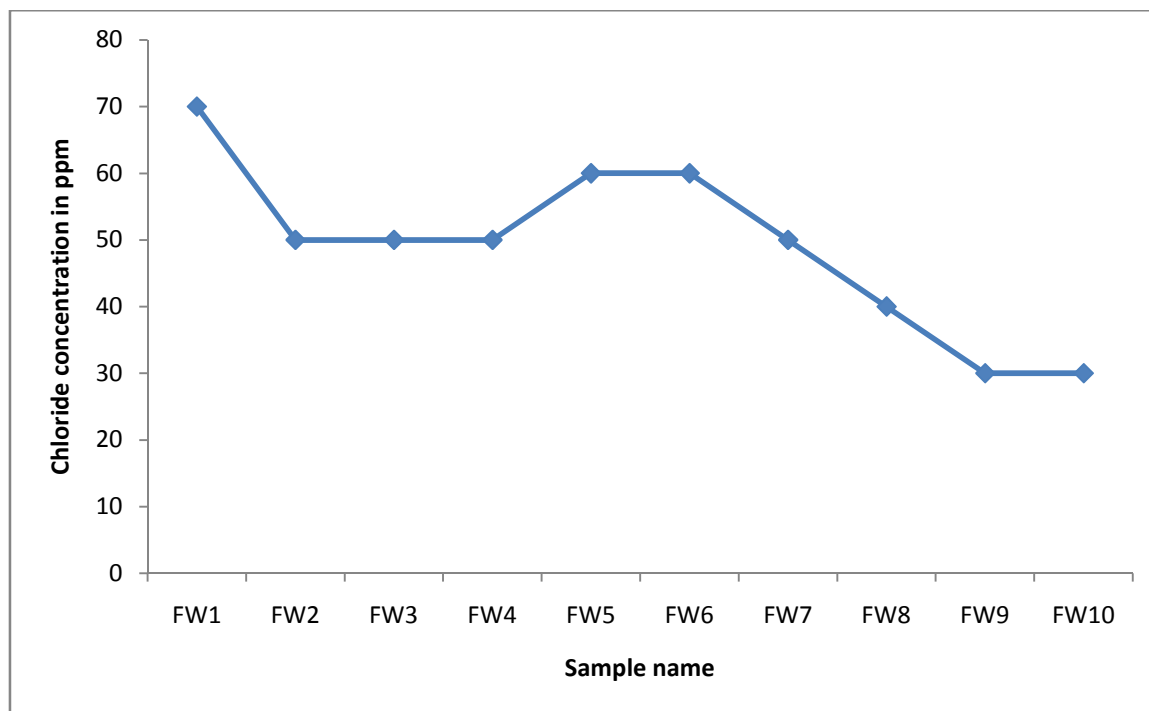


Figure 3.5: Variation of Chloride in ppm of Field water in different months

In the present study, the chloride concentrations in water samples were from a minimum of 30ppm to a maximum of 70ppm. Chloride concentration is very high in the sample FW1 and is very low in samples FW9 & FW10. In all the water samples, chloride was found to be within the permissible limits.

3.1.4 PHOSPHATE

Phosphate analysis of nearby well water showed that the phosphate ion was completely absent in all samples.

The phosphate ion concentration of field water in different months is given in Figure 3.6. Result shows that the phosphate concentration ranges from 0ppm to 1ppm in field water samples. Phosphate ion concentration in FW4 & FW5 samples was found to be slightly more than the permissible limit. The maximum permissible limit of Phosphate ion in drinking water is 0.03ppm by WHO (1983). The concentration is moderately more than the permissible limit

in samples FW1 & FW2. This may be due to the addition of chemical fertilizers in the field during that time.

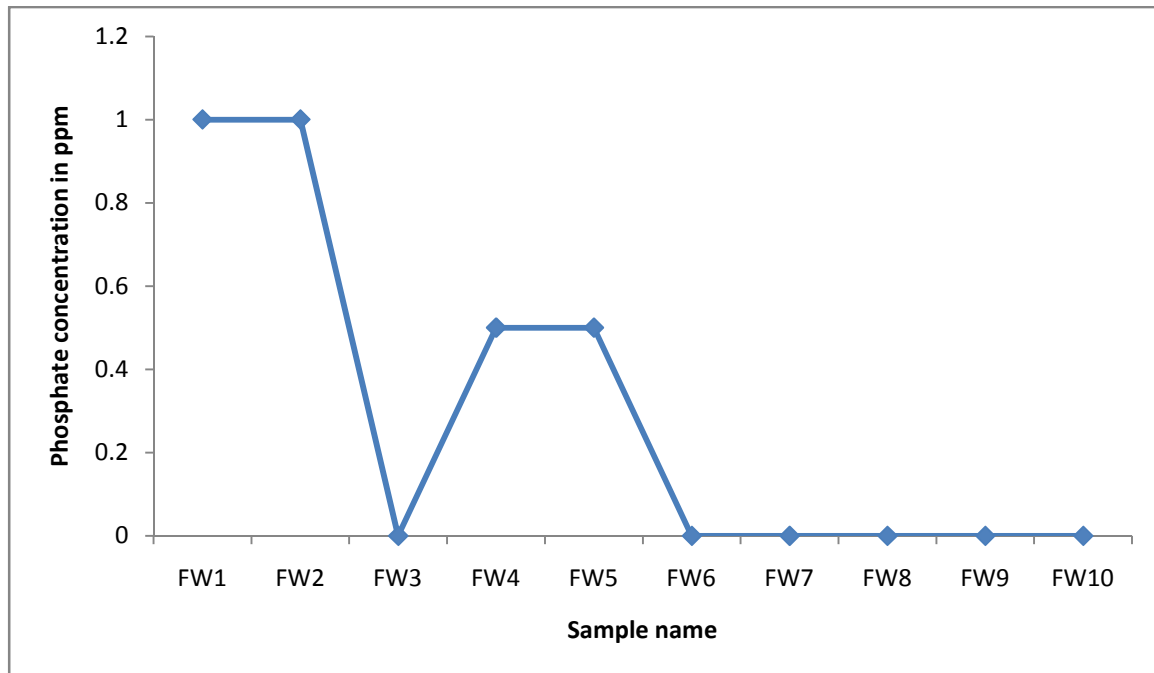


Figure 3.6: Variation of Phosphate in ppm of Field water in different months

3.1.5 NITRATE

The nitrate concentration of well water in different months is given in Figure 3.7.

The nitrate concentration in water was found to be from a minimum of 5 ppm (Sample WW1) to a maximum of 30ppm (Sample WW5). Nitrate concentration in all water samples are not within the permissible limits. The maximum permissible limit of nitrate for drinking water is 10ppm by WHO (1983). When urea is applied to the soil it gets transformed to ammonium (NH_4^+) by soil enzymes, which tend to be strongly adsorbed on soil particles. This adsorption inhibits the movement of ammonia through the soil. Ammonia is an energy rich substance and certain soil bacteria can utilize this energy by decomposing the ammonium to nitrate (NO_3^-). Unlike ammonia, nitrate is not adsorbed on soil particles and therefore, moves readily with water in the soil. Nitrate that is not taken up by roots of plants or soil micro-organisms can be transported to ground and surface water by a variety of mechanisms. The highest nitrate ion content was observed during April for Sample WW5.

Compared to monsoon and post monsoon periods higher values of nitrate concentration were observed during April. In monsoon the water is diluted by rain, there by nitrate concentration comes down.

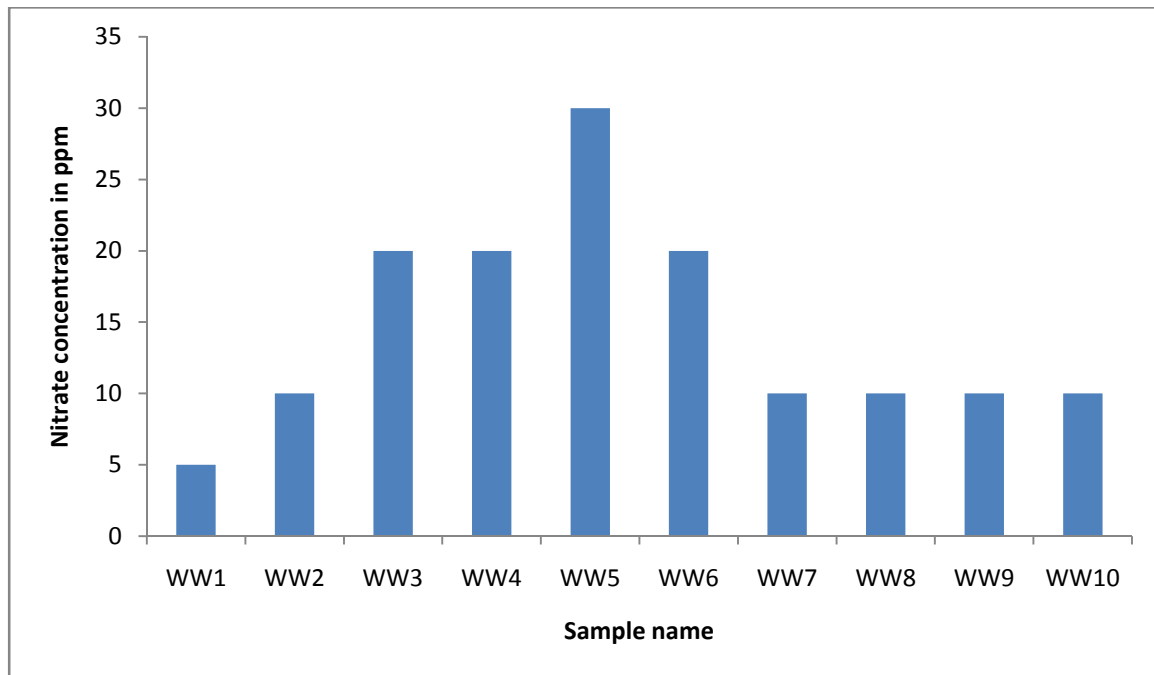


Figure 3.7: Variation of Nitrate in ppm of well water in different months

The variation nitrate of Field water in different months are given in Figure 3.8.

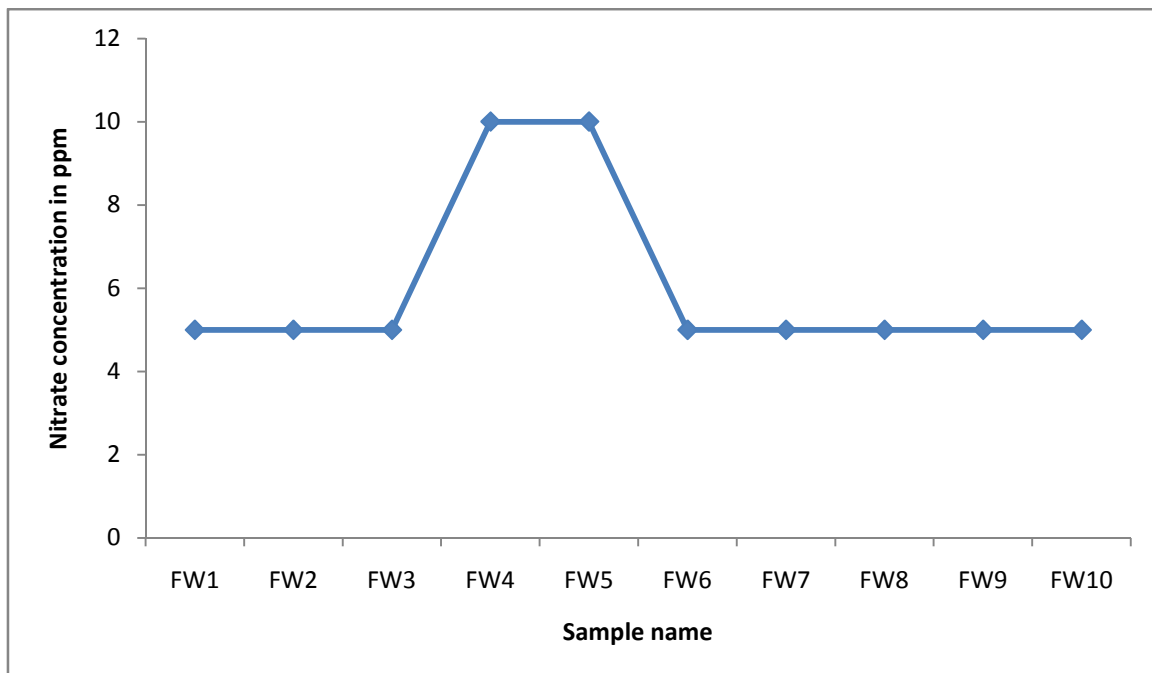


Figure 3.8: Variation of Nitrate in ppm of Field water in different months

Nitrate concentration in field water varies from 5 to 10 ppm. The maximum value observed is 10 ppm during the months of March and April for samples FW4 and FW5 respectively. Nitrate content in the field water samples is within the permissible limits.

3.1.6. SULPHATE

Sulphates are widely distributed in nature and may be present in natural water too. Agricultural activities and sewage disposal in and around the water bodies induce sulphates. Sulphates occur naturally in water as a result of leaching from minerals. Excess sulphate in water may cause intestinal disorders. The variation sulphate of well water in different months are given in Figure 3.9.

The sulphate concentration found to be between 8 ppm (Sample WW1) to 30 ppm (Sample WW6). Maximum permissible limit of sulphate for drinking water is 22.5 ppm by WHO (1983). Results show that the sulphate ion concentration in the well water is not within the limits during for samples WW5 (April), WW6 (May) and WW7 (June). Very high value in May (Sample WW6) may be due to decrease in the availability of water in summer.

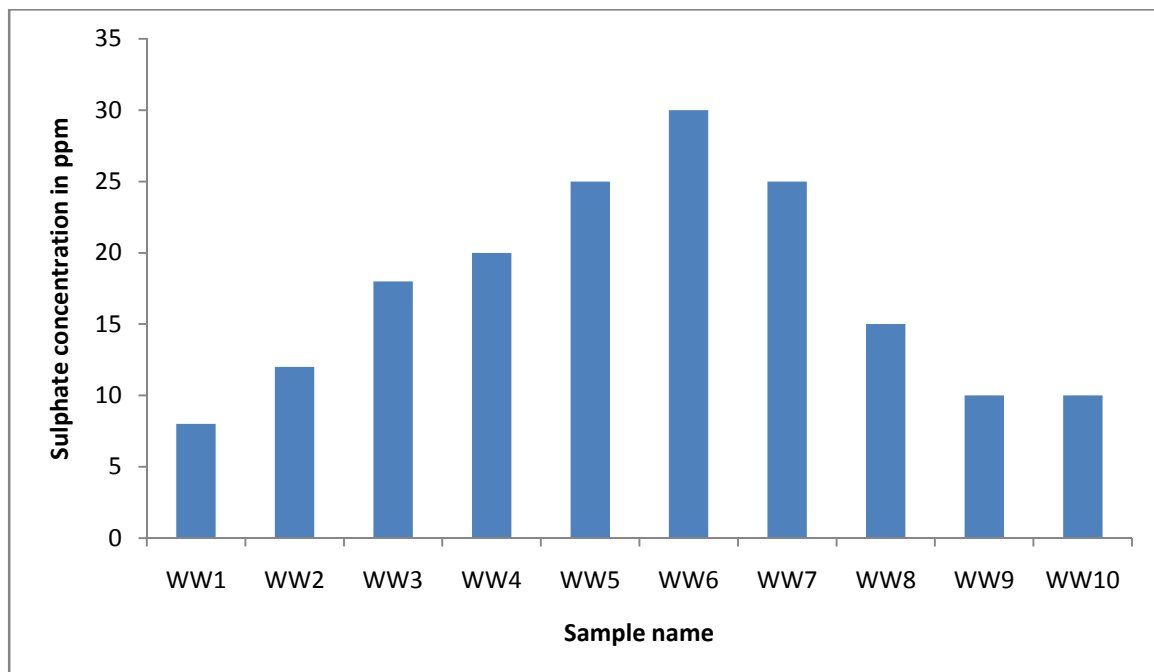


Figure 3.9: Variation of Sulphate in ppm of well water in different months

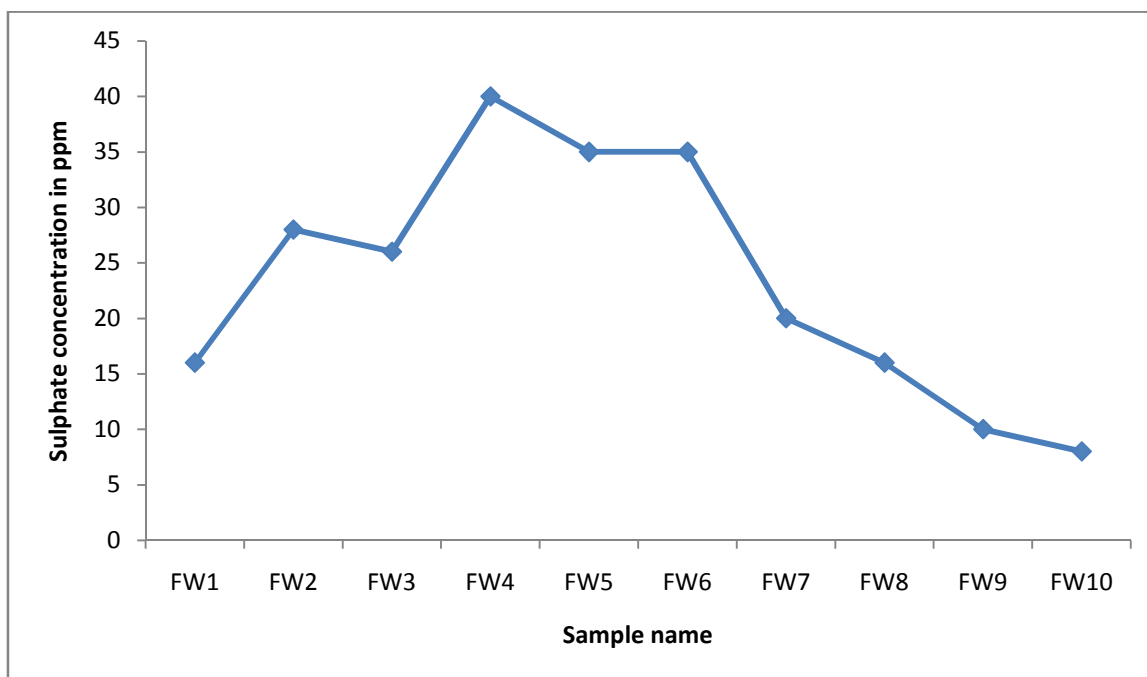


Figure 3.10. Variation of Sulphate in ppm of Field water in different months

Analysis showed that the sulphate ion concentration of field water ranges from 8ppm to 67ppm. The maximum permissible limit of sulphate ion concentration for drinking water is 22.5 ppm (WHO 1983). Higher sulphate ion concentration of sample WW4 is due to the low volume of water in paddy field.

3.1.7. AMMONIUM

Analysis of well water samples showed the complete absence of ammonium. The permissible value of ammonium in drinking water is between 0ppm to 1.5ppm. All the values are within the limit.

The results of the field water analysis are shown in Figure 3.11. Ammonium ion concentration of samples varies from 0.5 to 1 ppm. This shows that the ammonium concentration not exceeded the permissible limit.

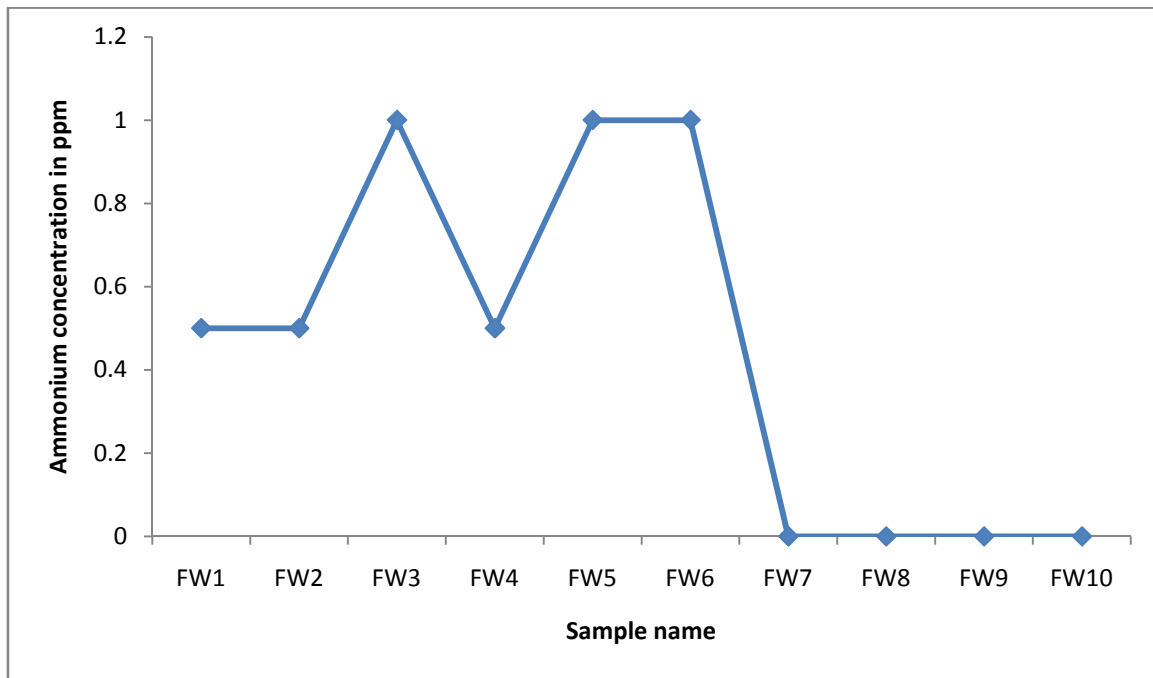


Figure 3.11: Variation of ammonium in ppm of Field water in different months

3.1.8. IRON

The analysis of well water samples showed complete absence of Iron. The maximum permissible limit of Iron in drinking water is 0.3ppm.

The results of the field water analysis are shown in Figure 3.12.

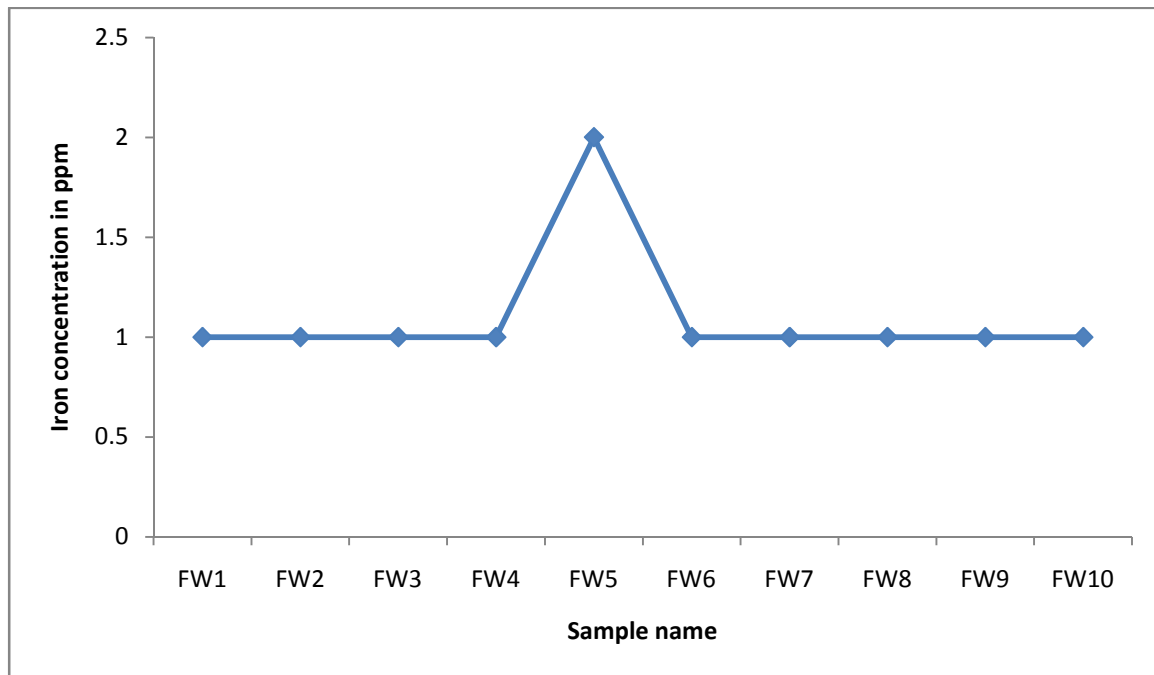


Figure 3.12: Variation of Iron in ppm of Field water in different months

Iron concentration in field water was found to be 1 ppm in all the samples except FW5(2 ppm). The Field water analysis shows that the concentration of Iron is above the permissible limit in all months. Two samples (WW1 and WW5) showed highest value of 3 ppm. The high value of Iron in sample FW5 may be due to the decrease in volume of water in April.

3.1.9 CHROMIUM

Chromium was not detected in the analysis of paddy field water and well water. All samples are free from chromium.

3.1.10. DISSOLVED OXYGEN (DO)

The optimum value of DO for good quality water is 8-15ppm which ensures a healthy aquatic life in water medium. Low DO value indicates water pollution which can even kill fish and other organisms of the water. Non polluted water normally remain saturated with dissolved oxygen. It can be easily depleted by oxygen demanding chemicals such as ammonium nitrites, ferrous iron and hydrogen sulphide.

The results of the well water analysis are shown in Figure 3.13.

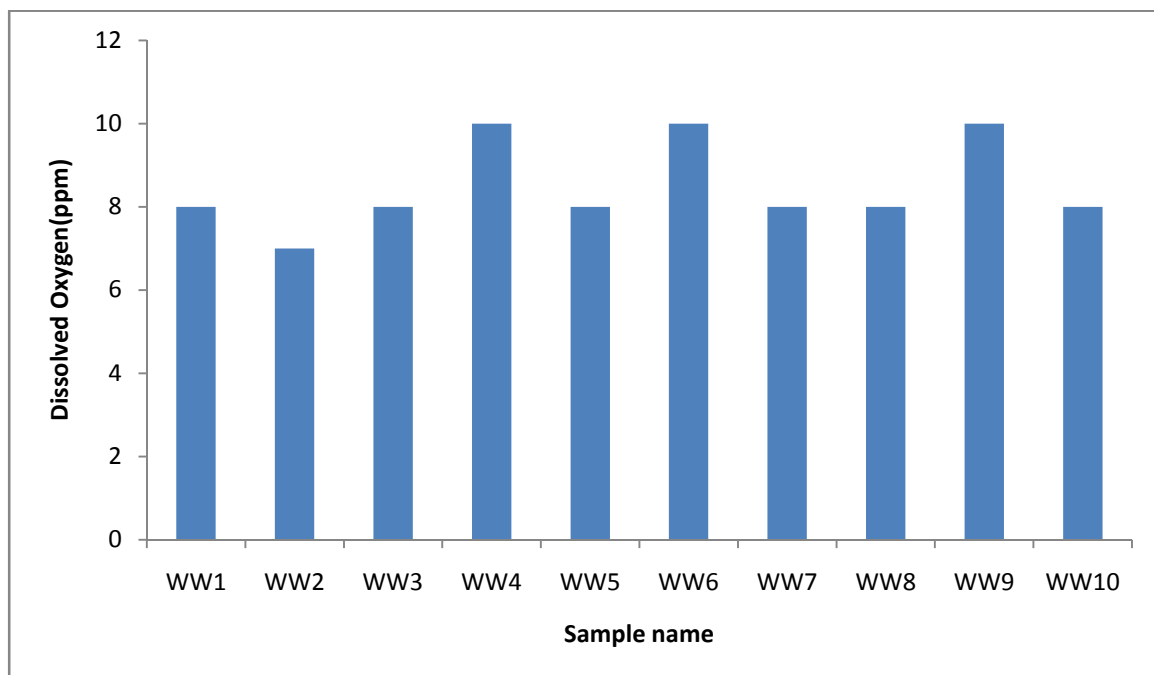


Figure 3.13: Variation of DO in ppm of well water in different months

Present investigation shows that the dissolved oxygen of ground water changes from a minimum of 7ppm to a maximum of 10 ppm. Dissolved oxygen content of all samples was found to be within the permissible limit. This indicates the presence of high Oxygen content in water samples.

The results of the field water analysis are shown in Figure 3.14.

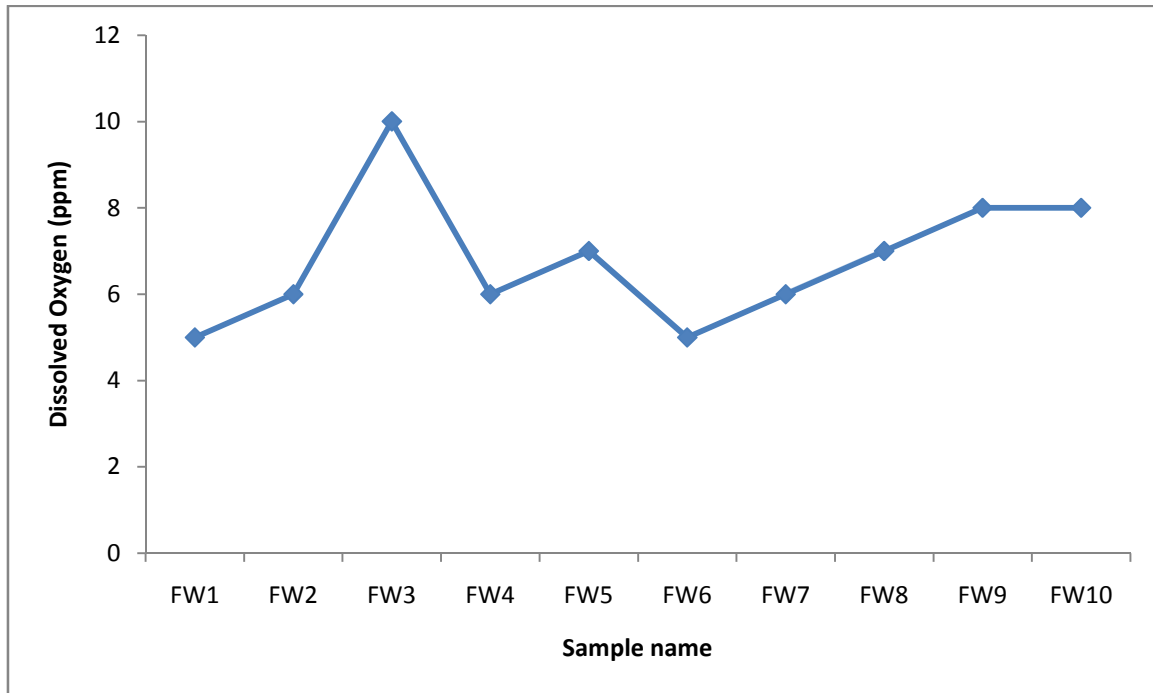


Figure 3.14: Variation of DO in ppm of Field water in different months

Above figure shows that DO of field water sample FW3 is very high during the month of February. The higher level of nutrient loaded and other factors result in decreased level of dissolved oxygen in water samples.

3.1.11. CHEMICAL OXYGEN DEMAND (COD)

Chemical oxygen demand determines the oxygen required for chemical oxidation of organic matter. COD conveys the amount of dissolved oxidisable organic matter including the non-biodegradable matters present in it. The minimum values of COD in different water samples indicate low organic pollutants, while maximum concentration indicates higher concentration of pollutants. The tolerance level of COD as per BIS standard for drinking water is 200ppm.

The monthly values of chemical oxygen demand are given in Figure 3.15.

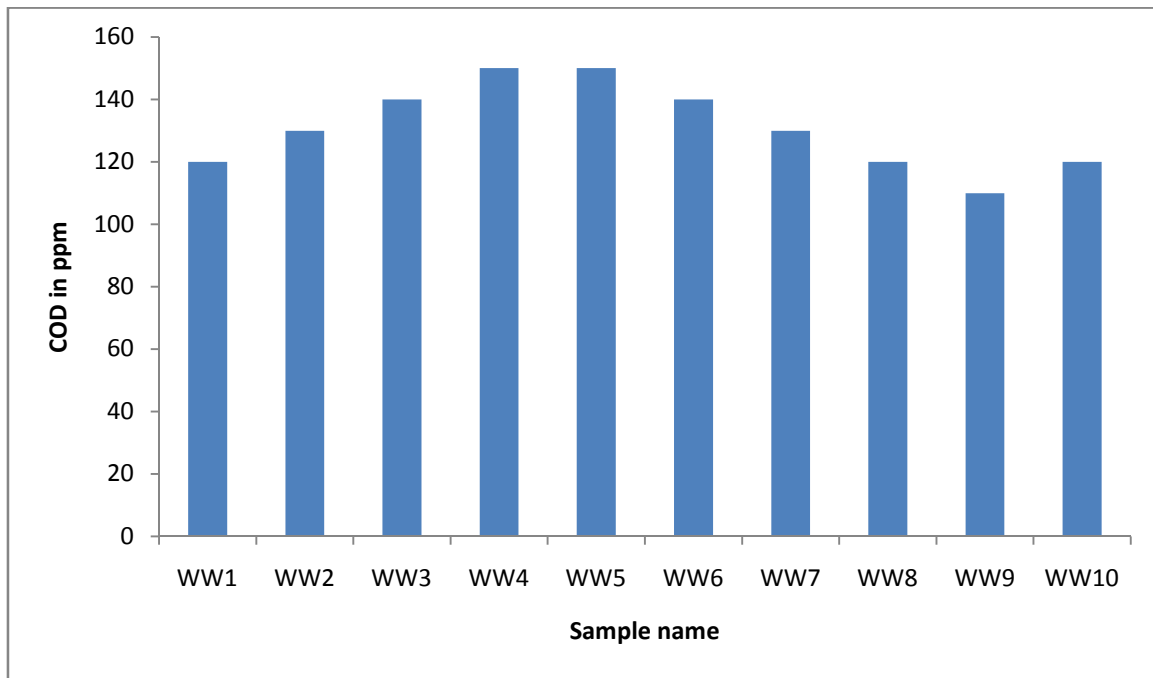


Figure 3.15: Variation of COD in ppm of well water in different months

During the present study, the COD in water varied from a minimum of 120ppm to a maximum of 150ppm. Higher value of 150ppm found for samples WW4 & WW5 may be due to decrease in volume of water. Since the values are within the permissible limit we can say that the well water contains lower pollutants.

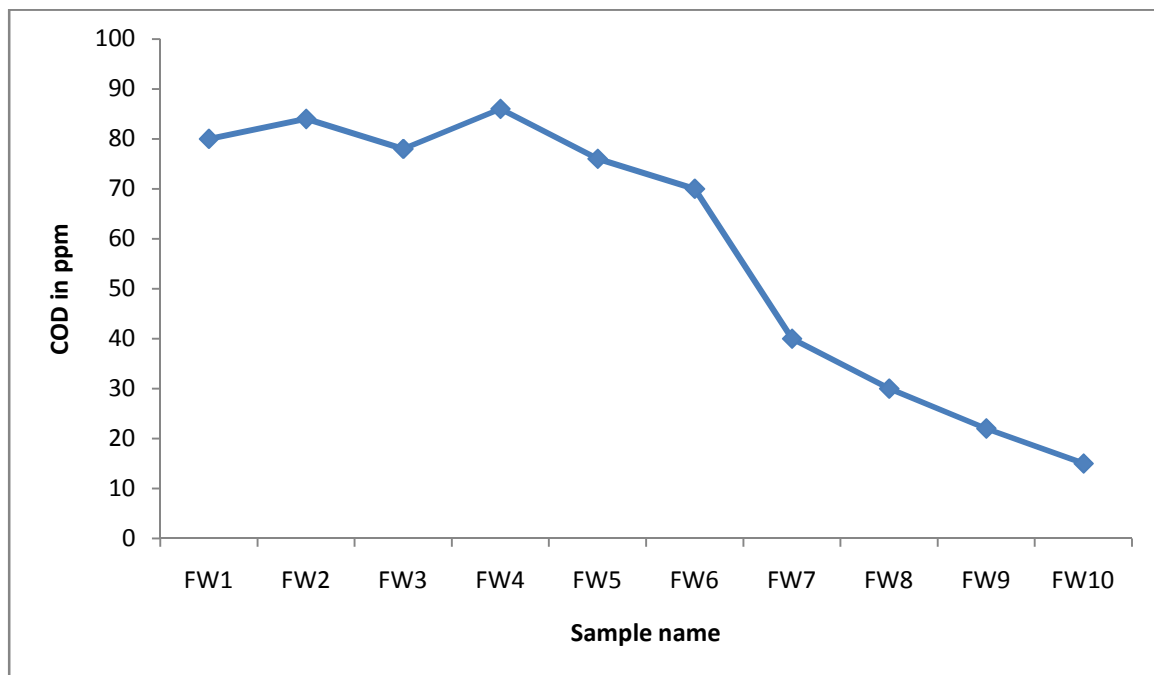


Figure 3.16: Variation of COD in ppm of Field water in different months

The monthly variations of chemical oxygen demand of field water is given in Figure 3.16. While comparing the well water and field water analysis results the former is having less organic pollutant than latter.

The COD of field water varied from 22 to 86ppm. Values are very low compared to well water samples. This indicates that the running water in the field removes the non-biodegradable matter from the land.

3.1.12. TOTAL HARDNESS

Hardness in drinking water is defined as those minerals that dissolve in water having a positive electrical charge. It is primarily due to the presence of ions of calcium and magnesium in water. Dissolved iron and manganese also satisfy the definition of hardness, but typically make up only a very small fraction of total hardness. According to WHO (1984), the permissible limit of total hardness is 120ppm. The results of well water analysis are shown in Figure 3.17.

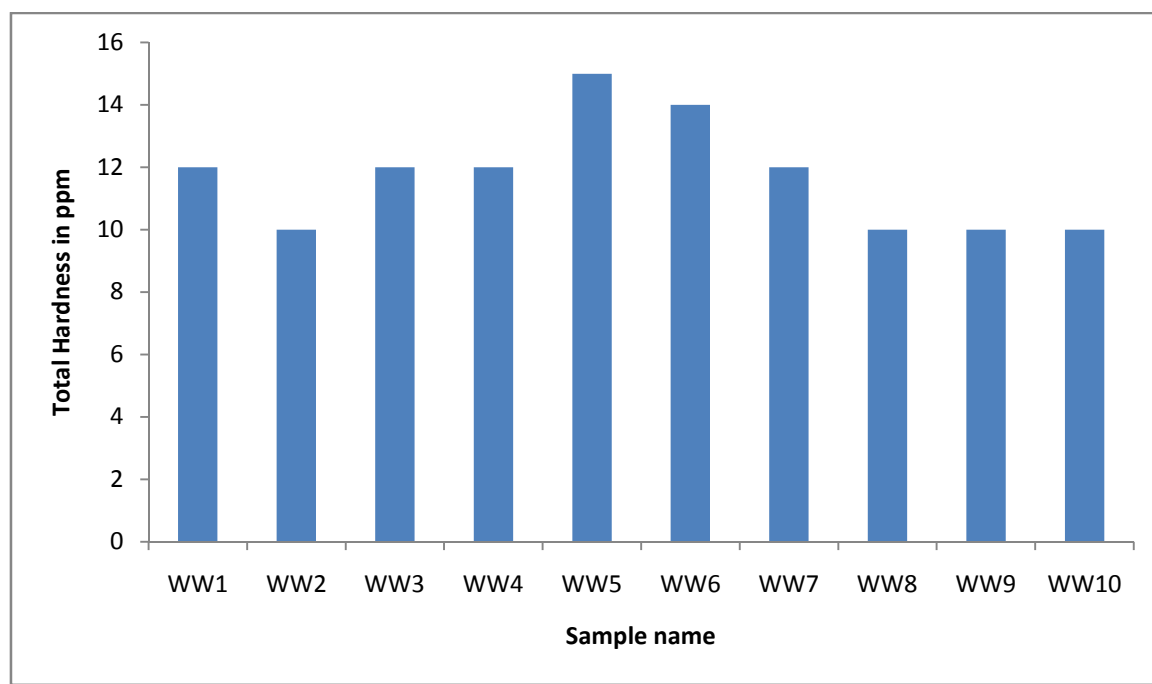


Figure 3.17: Variation of Total Hardness in ppm of well water in different months

The minimum and maximum concentration of total hardness in this analysis found to be 10-15ppm. The observed values are very low compared to the permissible limit. This indicates that the hardness of well water not affected by the action of pesticides at the field.

The results of field water analysis are shown in Figure 3.18.

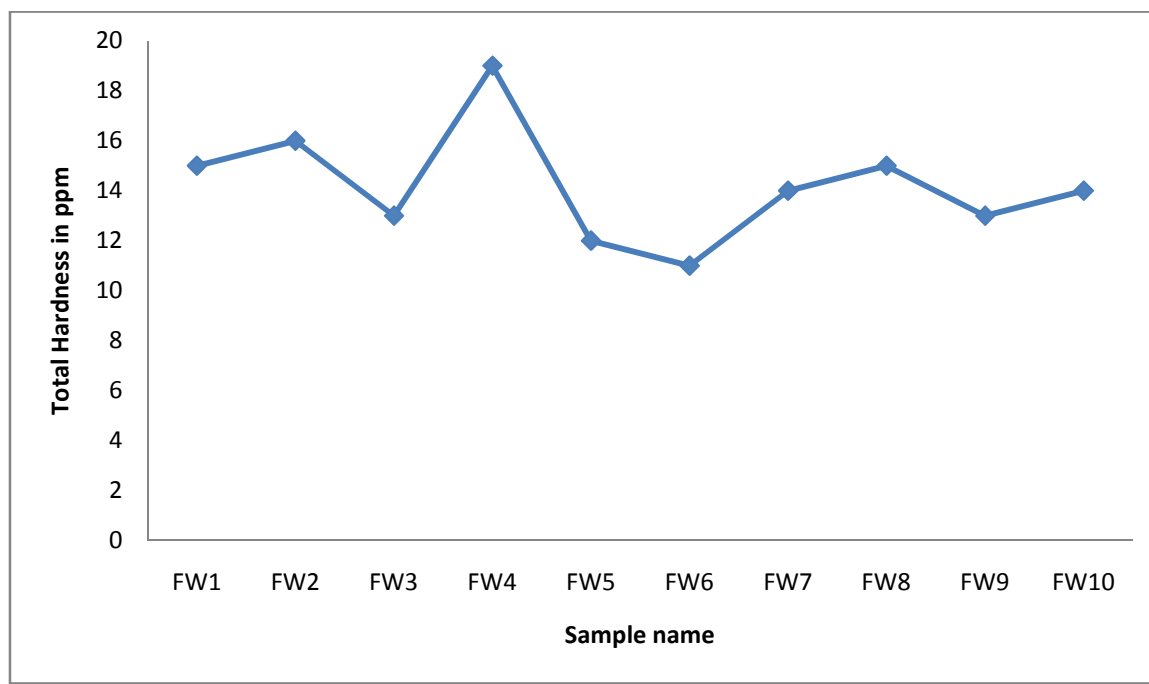


Figure 3.18: Variation of Total Hardness in ppm of Field water in different months

Total hardness of water samples collected from the field vary from 11ppm to 19ppm. Values of the samples not exceeded the permissible limit for drinking water. This shows that the usage of pesticides in the field water not affect the hardness of water in the field.

3.1.13. CONDUCTIVITY

The conductivity measurement provides an indication of ionic concentrations. It depends upon temperature, concentration and types of ions present. According to WHO, the desirable and permissible limits of EC is specified as 106 and 121 $\mu\text{S}/\text{cm}$ at 25⁰c respectively.

Variation of conductivity in μs of well water in different months is given in Figure 3.19.

EC of well water ranges from 120 to 160 $\mu\text{S}/\text{cm}$. Figure indicates that except sample WW10 all other samples have the values above the permissible limit. Higher value of 160 for sample WW5 observed may be due to increase in concentration of ions arising from the decrease in volume of water. EC reflects the total dissolved content in ground water.

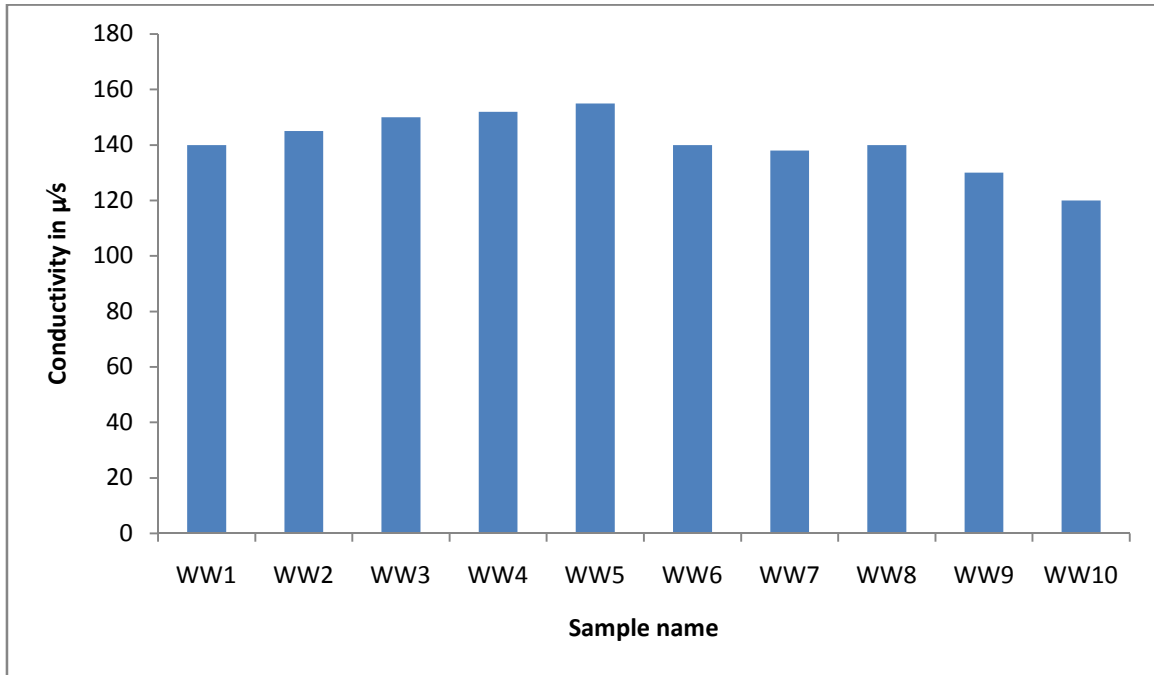


Figure 3.19: Variation of conductivity in μ/s of well water in different months

Variation of conductivity in $\mu S/cm$ of Field water in different months is given in Figure 3.20.

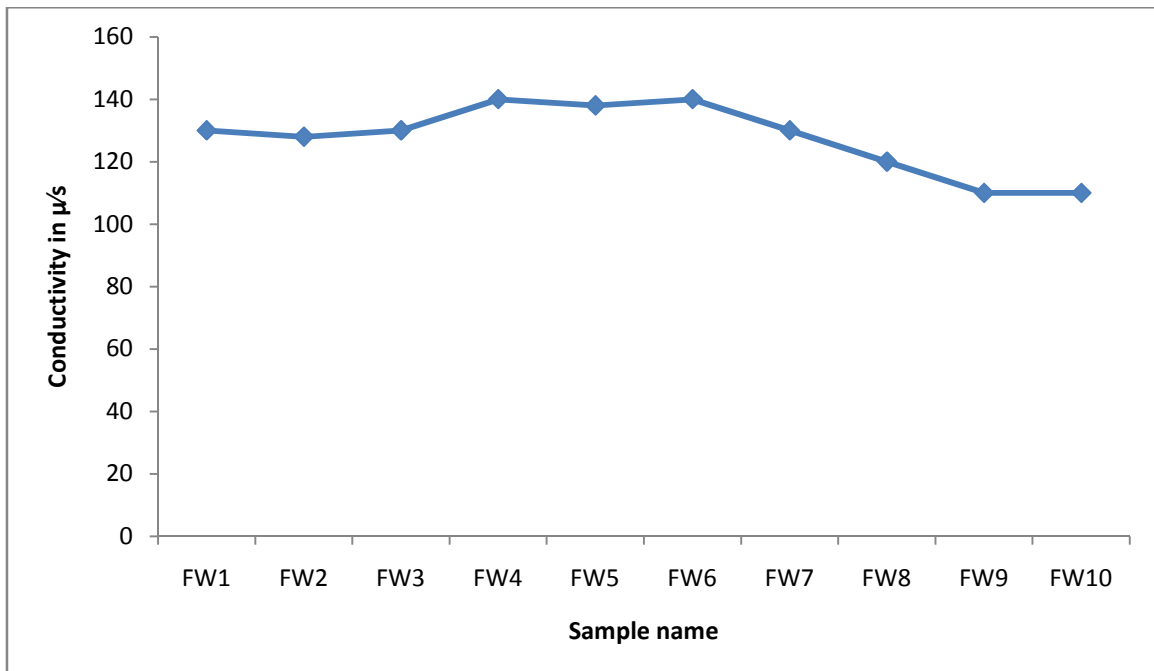


Figure 3.20: Variation of conductivity in $\mu S/cm$ of Field water in different months

EC of field water ranges from 110 to 140 $\mu\text{S}/\text{cm}$. The EC values in most of the samples (FW1 to FW7) are above the permissible limit. This may be due to the higher concentration of ions in water.

3.1.14. TOTAL DISSOLVED SOLIDS (TDS)

The maximum value of TDS of ground water 500 mg/l. Low TDS values were reported in ground water. The higher concentration of dissolved solids will impart a peculiar taste to water and reduce its portability.

Variation of TDS of well water is given in Figure 3.21.

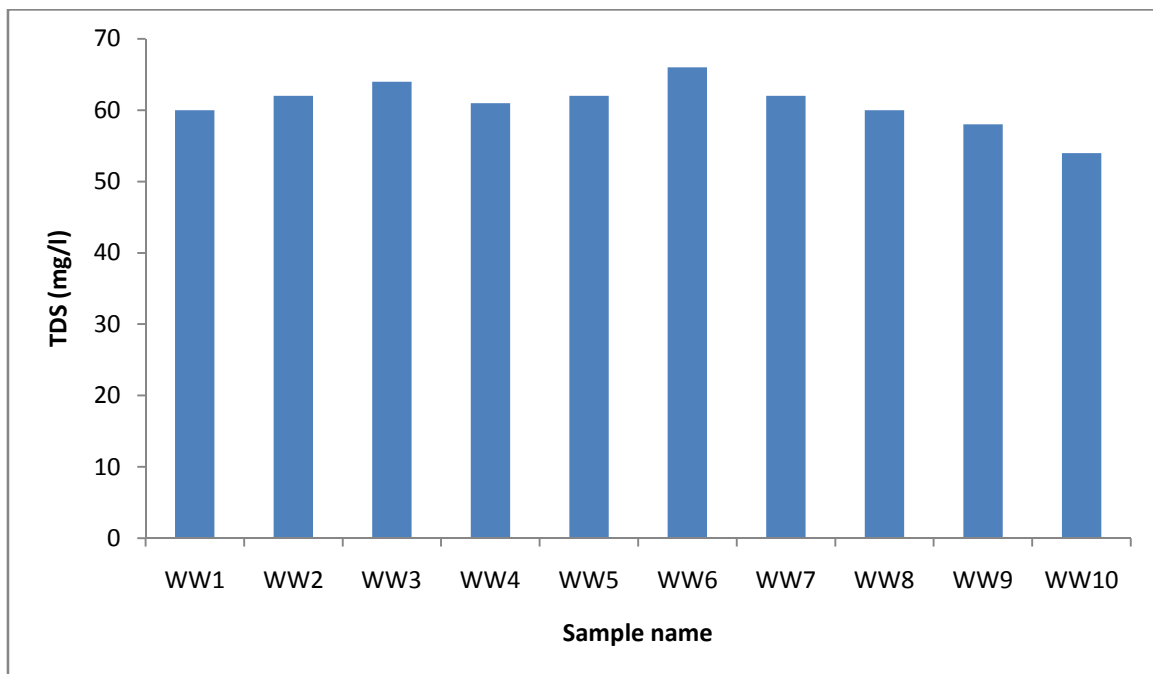


Figure 3.21: Variation of TDS in mg/l of well water in different months

TDS values of the well water samples varied from 54 to 66. Here the values are within the permissible limit.

Variation of TDS in mg/l of Field water in different months is given in Figure 3.22.

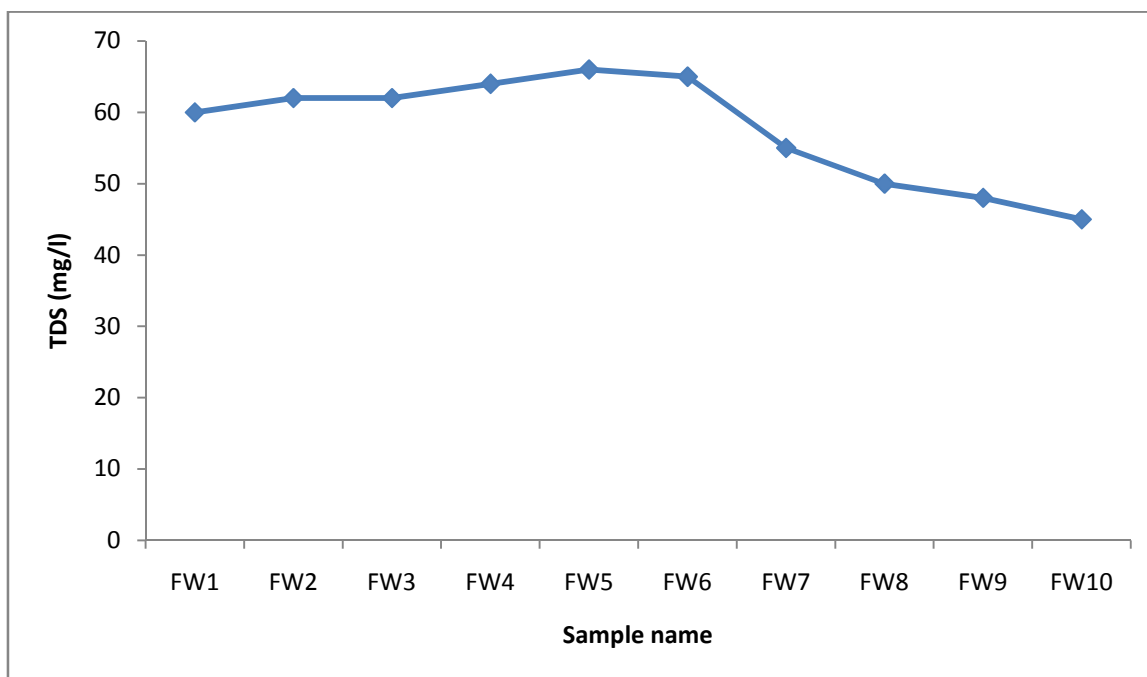


Figure 3.22: Variation of TDS in mg/l of Field water in different months

The results of field water analysis show that the TDS values of the samples are below the limit.

3.2 PESTICIDES

Commonly used pesticides in paddy field are Ekalux (Quinalphose), Malathion, Monochrotophos etc. Four samples were collected from paddy field. PFW₁ (Dec 2014), PFW₂ (Jan 2015), PFW₃ (Feb 2015) and PFW₄ (March 2015). The samples were analysed in Nawal analytical laboratories. They analysed the presence of fourteen different types of pesticides like Ekalux, Malathion etc. usually used in the paddy fields. The samples are analysed according to Test protocol USEPA 525.2 (United States Environmental Protection Agency). Results of the tests are given in Table 3.2.

The first sample PFW₁ was collected from the paddy field on the same day of pesticide spray. Pesticide content was found in the sample. The second sample PFW₂ was collected from the paddy field after seven days of pesticide spray. Pesticide content was not found in the sample. Third sample PFW₃ was collected after three days after pesticide spray. Pesticide content was not found. Fourth sample PFW₄ was collected after two days of pesticide spray. In this case also pesticide was not found. From the results it is clear that pesticides applied in the paddy field water does not sustain in the water for a long period.

Table 3.2: Pesticide analysis

Parameters	PFW ₁	PFW ₂	PFW ₃	PFW ₄	WW2	WW6
Monocrotophos (µg/l)	*ND	ND	ND	ND	ND	ND
Ethion (µg/l)	ND	ND	ND	ND	ND	ND
Chlorpyrifos (µg/l)	ND	ND	ND	ND	ND	ND
Phorate (µg/l)	ND	ND	ND	ND	ND	ND
Batachlor (µg/l)	ND	ND	ND	ND	ND	ND
Phorate Sulphone (µg/l)	ND	ND	ND	ND	ND	ND
Alachlor (µg/l)	ND	ND	ND	ND	ND	ND
Methyl Parathion (µg/l)	ND	ND	ND	ND	ND	ND
Methyl Paraoxon (µg/l)	ND	ND	ND	ND	ND	ND
Malathion (µg/l)	ND	ND	ND	ND	ND	ND
Malaaxon (µg/l)	ND	ND	ND	ND	ND	ND
Phorate Sulfoxide (µg/l)	ND	ND	ND	ND	ND	ND
Isoroturon (µg/l)	ND	ND	ND	ND	ND	ND
Ekalux EC 25 (µg/l)	10.0	ND	ND	ND	ND	ND

*ND - Not Detected

Two water samples WW2 10m(10-01-2015) and WW6 10m(14-05-2015) from a well situated 10m distance from the paddy field were collected and analysed in Nawal analytical laboratories (Test protocol USEPA 525.2).No pesticide content was found in the well water. From the results it is clear that pesticides applied in paddy field is not reaching in to well water.

3.3 ANALYSIS OF WATER SAMPLES FROM WELLS AT DIFFERENT DISTANCES

Water from the wells at different distances from the Kole Wet Land are collected and analysed. Name of the wells under consideration and their distances from the Kole Wet Land is given in Table 3.3.

Table 3.3: The names of wells at different distances

Name of sample	W 1	W 2	W 3	W4	W5	W6	W7	W8	W9	W10
Distance from the field	10m	50m	100m	300m	500m	700m	900m	1100m	1300m	1500m

These samples also analysed to detect various parameters like pH, Fluoride ion concentration, Chloride ion, Phosphate, Nitrate, Sulphate, Iron, Ammonium etc. The results obtained are given in the Table 3.4.

The analysis of the water from wells at different distances from the Kole wet land shows that the anions like sulphate, nitrate and chloride are present in the well water. But the values are in the permissible limit. So pesticides applied in paddy field are not contaminating the neighbouring well water.

Table 3.4: Analysis of water from the wells at different distances from the land

Parameters	W 1	W 2	W 3	W4	W5	W6	W7	W8	W9	W10
pH	6	6	5.8	5.8	5.6	5.8	5.9	6	6	6
Fluoride(ppm)	0	0	0	0	0	0	0	0	0	0
Chloride(ppm)	40	50	70	60	60	50	40	40	30	40
Phosphate(ppm)	0	0	0	0	0	0	0	0	0	0
Nitrate(ppm)	5	10	15	20	20	15	10	10	10	10
Sulphate(ppm)	10	20	12	15	20	25	20	15	10	12
Iron(ppm)	0	0	0	0	0	0	0	0	0	0
Ammonium(ppm)	0	0	0	0	0	0	0	0	0	0
DO(ppm)	8	8	9	8	10	8	8	8	8	7
COD(ppm)	80	70	60	70	70	70	60	50	50	50
Total hardness (ppm)	12	10	10	8	10	12	10	8	10	10
conductivity μ /s	90	95	90	95	100	100	90	85	80	75
TDSmg/l	50	52	50	51	54	53	52	43	40	38

Table 3.4 also show that the ions like fluoride, phosphate, iron and ammonium are completely absent in the well water. This also shows that the water in this area is completely free from hazardous metals and anions like

phosphate, fluoride etc. But the presence of nitrate ion is more than permissible value in the samples. This may even lead to serious health problems like cancer. As the water is free from fluoride, the health problems arising from tooth decay can be discarded. The pH values are lower than the permissible values. The pH value ranges between 6 to 5.8. This shows that the water samples from all wells are slightly acidic. All other values are within the permissible limit.

CHAPTER 4

CONCLUSION

The present work aims to assess the effects of chemical fertilizers and pesticides on water quality in the selected agricultural area of division 43 of Thrissur Corporation and to evaluate the water quality parameters of groundwater near the agricultural area. This will help to know the suitability of well water for drinking purpose.

pH value of well water near the field was deviate from 5.5 to 6.5. Reduction of volume of water during summer made the ground water more acidic. Field water also showed the similar behaviour during summer. It is observed that the fluoride, residual chlorine, phosphate, nitrite, chromium, iron, and ammonium are completely absent in the well at 10m distant from the Kole wet land. This shows that the water in this well is completely free from hazardous metals and anions.

In the case of field water fluoride, phosphate, and nitrite were present to a small amount. Concentration of all the above were within the permissible limits. The field water analysis showed that the concentration of Iron is above the permissible limit during the period of analysis.

The anions like nitrate, chloride, and sulphate were present in both well water and field water.

Non polluted water normally remain saturated with dissolved oxygen. Present investigation shows that the dissolved oxygen of ground water changes from a minimum of 7ppm to a maximum of 10 ppm. The optimum value of DO for good quality water is 8-15ppm which ensures a healthy aquatic life. This indicates that the water is free from oxygen demanding chemicals such as ammonium, nitrites, ferrous iron and hydrogen sulphide.

Chemical oxygen demand (COD) conveys the amount of dissolved oxidisable organic matter including the non-biodegradable matters present in it. Present study shows that the COD in well water varied from 120ppm to 150ppm and COD of field water varied from 22 to 86ppm. Since the values are within the permissible limit we can say that the well water contains lower pollutants. Values of field water samples are low compared to well water samples because

the running water in the field removes the non-biodegradable matter from the land.

Hardness of water is due to the presence of ions of calcium, magnesium dissolved iron and manganese. Total hardness of well water samples changes 10 ppm to 15 ppm and samples of field vary from 11 ppm to 19 ppm. The observed values are very low compared to the permissible limit. Hence the use of pesticides in the field water not affects the hardness of water in the field and the water in the well near to the field.

Electrical conductivity (EC) reflects the total dissolved content in ground water. EC of well water ranges from 120 to 160 $\mu\text{S}/\text{cm}$ and EC of field water ranges from 110 to 140 $\mu\text{S}/\text{cm}$. Higher values of EC for some samples is due to the lowering of volume of water during summer. Total dissolve solid values of the well water samples varied from 54 to 66. Higher concentration of dissolved solids will impart a peculiar taste to water and reduce its portability.

Presences of fourteen different types of pesticides like Ekalux (Quinalphose), Malathion, Monochrotophos etc. usually used in the paddy fields were analysed. The sample collected from the paddy field on the same day of pesticide spray showed pesticide content. All other samples not showed the presence of pesticide. So it is clear that pesticides applied in the paddy field water does not sustain in the water for a long period.

The analysis of the water from wells at different distances from the Kole wet land shows that the anions like sulphate, nitrate and chloride are present in light quantities. Pesticides applied in paddy field are not contaminating the neighbouring well water. The ions like fluoride, phosphate, iron and ammonium are completely absent in the well water.

Some suggests that reducing the amount of pesticides and fertilizers used in agriculture will help alleviate the negative effects and may not hurt crop yields. New developments in leach pits and slurry stores help to control the nitrate that comes from stored manure. By installing these prevention methods and reducing the amount of fertilizer used, the concentration of nitrate in the groundwater can be reduced over time. Treatment processes, such as ion exchange can have an immediate effect on reducing levels in drinking water. These processes do not remove the entire nitrate, but can help to bring the concentration down to the suggested level of 10 ppm.

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