Effect of Extensive use of Chemical fertilizers on Nitrate and Phosphate Enrichment in Water resources of Selected Agricultural Areas of T.Narasipura Taluk, Mysore District, Karnataka, India

Divya J and Belagali S.L.

* Department of Studies in Environmental Science, University of Mysore, Mysore-570 006, Karnataka, India
divyajenv@gmail.com

Abstract

Application of chemical fertilizers is considered to be one of the major pollution sources to water bodies, caused due to agriculture. A nutrient loss from agricultural activities causes many problems to the aquatic environment. When more quantity of fertilizers are applied, which are not in line with the codes of good agricultural practice, nutrient losses may take place through leaching and surface runoff and enter into near-by water bodies. During the present study, 15 water samples were collected around agricultural areas of T.Narasipura taluk of Mysore district. The water samples were analysed for chemical fertilizer residues and physico-chemical characteristics. From the study, it was confirmed that, most of the water samples were contaminated with urea and DAP residues. Nitrate, Nitrite, Phosphate and basic cations concentrations were found to be higher than the permissible limits of WHO standards, which is due to leaching and surface run-off of nutrients from agricultural lands. Therefore, a rational use of chemical fertilizers should be implemented in order to benefit soil sustainability as well as water quality.

Key words: Chemical fertilizers, Nitrate, Phosphate and Rational use.

Introduction:

Agriculture is the single largest user of fresh water on a global basis, which has a significant impact on the quality of surface and ground water. Nitrate and phosphate pollution has been reported as a major problem in agricultural ecosystems, especially under intensive use of nitrogen and phosphorous fertilizers. Nitrate leaching is the most prevalent groundwater pollutant and it might represent a serious health problem. In many cases, it is difficult to quantify the impacts of agriculture on the quality of surface and ground water. Nitrogen and phosphorus fertilizers are the two most often used fertilizers in quantity. Nitrates and Phosphates occur in small amounts, in all aquatic environments, which are required to maintain the growth and metabolism of plants and animals. However, in excess amounts, these minerals can prove to be quite harmful through the process of eutrophication. Several scientists have studied mineral levels in different bodies of water, and have found that, the levels of phosphates and nitrates have heavy impact on the overall quality of the water and its inhabitants. The extent of nitrogen and phosphorus losses from agricultural soils depends on factors such as crops grown, amounts of slurry and mineral fertilizers applied, time and technique of application, soil type, hydrological characteristics and weather conditions. In view of this, the present study was carried out, in order to assess the effects with an objective, to study the effect of extensive use of chemical fertilizers on nitrate and phosphate enrichment in water resources of selected agricultural areas of T.Narasipura Taluk, Mysore District.

Material And Methods

Study Area: Agriculture is one of the major occupations in Narasipur taluk with paddy as major cultivable crop. The town geographically lies between 12^0 11' 502 2† N - 12^0 132 30'' Latitude and 76^0 53' 302 2† E and 76^0 54' 502 2† longitude and it is at an altitude of 638 m (2093 ft) from sea level. The commonly used chemical fertilizers in the study area are-urea and diammonium phosphate, in addition to this, farmyard manures is also used. The average annual application rate of nitrogenous and phosphorous fertilizers is over 200-300 kg/ha of urea and 150-200 kg/ha of diammonium phosphate per cropping season, particularly in paddy cultivations. The soil type, which is predominant in the study area are clay soil. The description about sampling place, cropping pattern, fertilizer type and quantity applied in study area are presented in Table-I

Collection of water samples: Fifteen water samples were collected from selected agricultural lands of Mysore district, which include ground and channel waters. The water samples were collected in pre-sterilized plastic containers. The urea residues were quantified by diacetyl monoxime method and diammonium phosphate residues were calculated by using amount of phosphate present in water sample, considering molecular weight of DAP and

atomic weight of phosphate in DAP fertilizer. The pH and EC were measured by using pH meter and conductivity meter. Carbonates and bicarbonates were determined by titrimetric method. Calcium and magnesium were determined titrimetrically using standard EDTA method, sodium and potassium were determined by flame photometric method, chloride was determined by argentometric titration method. Nitrate was determined by phenoldisulphonic acid method.

Sl. No	Sampling stations of soil, water	Types of crops cultivated	Types of fertilizers used	Land type	Water source
1	Alasthikattehundi	Leguminous plants	Urea, DAP	Rain fed	Channel water
2	Bannahalli hundi	Horse gram, paddy	Urea, DAP	Rain fed	Channel water
3	Alagudu	Paddy	Urea, DAP	Irrigated land	Channel water
4	Kharuvatti	Coconut, tomato	Urea, DAP	Garden land	Bore well water
5	Kuruburu	Paddy	Urea, DAP	Irrigated land	Bore well water
6	Madralli	Paddy	Urea, DAP	Irrigated land	Channel water
7	Chuhalli	Paddy	Urea, DAP	Irrigated land	Channel water
8	Nilsogae	Paddy	Urea, DAP	Irrigated land	Channel water
9	Hosapura	Paddy	Urea, DAP	Irrigated land	Bore well water
10	T.Narasipura	Paddy	Urea, DAP	Irrigated land	Bore well water
11	Gargeshwari	Paddy	Urea, DAP	Irrigated land	Channel water
12	Hindvalu	Banana, papaya	Urea, DAP	Garden land	Bore well water
13	Kempayana hundi	Coconut, leafy vegetables	Urea, DAP	Garden land	Channel water
14	Bilagale hundi	Coconut, vegetables	Urea, DAP	Garden land	Bore well water
15	Hampapura	Banana, legumes	Urea, DAP	Garden land	Channel water

Table-1: Sampling Points with sampling codes, crop types and types of fertilizers applied for agricultural fields of T.Narasipura Taluk

Parameters	WHO Stds Desirable limits	W-1 C	W-2 C	W-3 C	W-4 B	W-5 B	W-6 C	W-7 C	W-8 C	W-9 B	W-10 B	W-11 C	W-12 B	W-13 C	W-14 B	W-15 C
pH	7-8.5	7.86	6.34	7.16	7.12	7.20	7.21	7.51	7.18	7.08	7.91	7.68	8.01	7.02	7.13	7.16
Conductivity	2500	480	720	980	640	630	580	380	760	950	1160	1040	980	460	560	990
Turbidity	3.8	0.32	0.78	0.59	0.50	0.91	0.62	0.31	0.41	0.46	0.34	0.32	0.72	0.16	0.18	0.29
TDS	500	380	526	279	460	340	240	460	310	630	720	710	198	170	187	420
Carbonates	50	75.3	79.2	146	163	200	67.4	94.2	132.	120.	182	162	130	121	68	131
Bicarbonates	500	416	314	327	243	416	518	194	421	336	437	317	298	309	190	384
T. Hardness	500	420	516	300	428	520	472	248	524	521	521	476	398	516	613	698
Calcium	100	184	216	217	256	216	92.2	64	198	90.7	98	77	86	94	132	156
Magnesium	150	98	112	99.6	138	69	54.3	34.7	97.6	104	76.1	74.4	86.7	72.8	89.7	92.2
Chloride	250-1000	247	427	339	179	164	174	146	252	174	196	216.3	165.6	137.4	98.2	90.1
DO	6.0	6.21	6.99	7.56	6.91	6.22	7.46	6.85	6.02	6.77	7.12	6.56	6.56	8.02	7.89	7.42
COD	10	12.6	12.9	13.9	17.2	16.5	13.2	14.7	22.3	18.9	22.1	18.3	14.6	15.6	12.7	15.2
Sodium	200	814	415	397	421	145	74.3	200	176	71.9	530	146	72.6	71.1	136	71
Potassium	12	19.7	71	61	26	47	28	40	32	14	14	29	35	19	60	47
Nitrate	50	110	95	121	150	50	51	112	105	103	100	95	194	172	160	172
Nitrite	0.02	-	-	-	-	-	0.01	0.2	0.4	0.02	-	-	0.01	-	-	-
Phosphate		5.9	5.1	5.7	4.8	3.3	3.1	3.7	4.2	5.3	3.8	6.9	5.9	4.7	3.9	4.0
Chemical fertilizer residues in ppm																
Urea		3.4	2.4	3.3	1.8	1.3	-	5.1	1.4	2.9	3.7	4.6	4.2	3.6	1.1	1.8
DAP		8.20	7.09	7.92	6.67	4.58	4.31	5.14	5.83	7.63	5.28	9.59	8.20	6.53	5.42	5.55

Table-2: Physico- chemical characteristics and Chemical fertilizer residues in water samples collected around selected agricultural areas of T.Narasipura Taluk

C-Channel water, **B**-Bore well water samples

Note – All the units are expressed in mg/l, except pH, conductivity (mmhos/cm) & turbidity in (NTU)

Results and Discussion:

The results of fertilizer residues and physico-chemical characteristics of water samples are presented in Table-2.

Urea: Urea is one of the nitrogenous fertilizers that has received wider attention in agriculture, because of its potential role for seedling damage, ammonia volatilization and water pollution problems. Urea enters surface and ground water through leaching and surface run off from agricultural lands. Its entry into ground water depends on soil texture. During the present investigation, the urea residues ranged from 1.1 to 5.1 ppm, Highest concentration of urea was reported in channel water and lowest in ground water.

Diammonium phosphate residue (DAP): The DAP residues ranged from a minimum of 4.31 ppm to a maximum of 9.59 ppm. Highest amount of DAP was reported in channel water, which is due to excessive run off of fertilizer from agricultural lands to near-by channels.

pH: pH is the measure of acidity or alkalinity of water. During the present study, pH of water samples ranged from a minimum of 6.34 to a maximum of 8.01. During the present investigation, the variation in the pH was noticed, for both ground and channel water samples which were found to be within the permissible limits of WHO standards. The results also show that, the alkaline pH is particularly due to presence of cations like Calcium, Magnesium and Sodium. This observation was in conformity with the findings of Azeez et.al (2000).

Electrical conductivity (EC): Electrical conductivity is the measure of capacity of water to carry electric current. It signifies the amount of total dissolved salts present in solution. During the present study, electrical conductivity of water ranged from a minimum of 380 to a maximum of 1160 mmhos/cm. The EC values in all the water samples were found to be within the permissible limits of WHO Standards.

Total dissolved Solids (TDS): The TDS of ground water ranged from a minimum of 170 to a maximum of 720 mg/l. High TDS values were reported in ground water and lowest for channel water. The higher concentration of dissolved solids imparts a peculiar taste to water and reduce its potability.

Carbonates and bicarbonates: Alkalinity of water is the capacity to neutralize a strong acid and it is normally due to the presence of carbonates, bicarbonates and hydroxides of calcium and magnesium. The carbonate concentration in water ranged from a minimum of 67.4 to a maximum of 200 mg/l. In all the water samples, the carbonate concentration were found to be higher. The bicarbonate concentration in water were from, a minimum of 190 to a maximum of 518 mg/l. The total alkalinity values for all the water samples were found to be within the desirable limits. Except W(6), all water samples were found to be within the permissible limits.

Calcium and magnesium: Calcium and magnesium concentration are directly related to hardness of water. The calcium and magnesium of water samples ranged from, a minimum of 64 to a maximum of 256 mg/l and 34 to 138 mg/l respectively. The high concentration of calcium and magnesium in the above water samples were due to the dissolution of lime stone. During the present investigation, except W (6), (7), (10), (11), (12), (13), all the other water samples were found to be within WHO standards. In all the water samples, magnesium concentration was found to be above the permissible limits of WHO standards.

Chloride: Chloride occurs naturally in all types of water samples. Chloride in natural water results from agricultural activities or some times, it could be due to dissolution of chloride from chloride containing rocks. During the present study, the chloride concentrations in water samples were from a minimum of 90.1 to a maximum of 427 mg/l. In all the water samples, chloride was found to be within the permissible limits.

Dissolved oxygen (DO): During the present investigation, the dissolved oxygen of ground water were from a minimum of 6.02 to a maximum of 8.02 mg/l. In all the sampling places, the dissolved oxygen content was found to be higher than the permissible limits, which indicates the presence of high Oxygen content in water samples. The higher level of nutrient load and other factors result in decreased level of dissolved Oxygen in water samples.

Chemical oxygen demand (COD): Chemical oxygen demand determines the oxygen required for chemical oxidation of organic matter. During the present study, the COD in water was from a minimum of 12.6 to a maximum of 22.3 mg/l. 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 indicates low organic pollutants, while maximum concentration indicate higher concentration of pollutants.

Sodium and potassium: The sodium and potassium concentrations in water samples ranged from a minimum of 71 to a maximum of 814 mg/l and 14 to 71 mg/l respectively. Among all the water samples, except W (1),

(2), (3), (4), (7), (10), all the water samples were found to be within the permissible limits.

In Ground water and surface water, the potassium contamination can result from the application of potassium fertilizers more than the required concentration. Potassium leaching from the soil is important from the perspective of plant nutrition. If fertilizer use and application to irrigation water exceeds the crop requirement, excess water will carry with it, soluble salts including potassium. This implies that, enrichment of potassium in surface and ground water is due to influence of urea fertilizers.

Nitrate: The nitrate concentration in water was found to be from a minimum of 50 to a maximum of 194 mg/l in all the water samples, which was found to be above the permissible limits. In the soil, when urea is applied, 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 plant roots or soil micro-organisms can be transported to ground and surface water by a variety of mechanisms.

Phosphate: The phosphate concentration in water was found to be from a minimum of 3.1 to a maximum of 6.9 mg/l. highest concentration was reported in channel water and lowest in ground water. In the studied area, intensive crop production, continuous application of phosphate fertilizer and farmyard manure have been used at levels exceeding crop requirements. Highest phosphate concentration was reported in channel water, which indicated that, diammonium of phosphate, is the major source of enrichment of phosphate in water samples.

	pH	EC	TU	TDS	CO^{3-}	HCO^{3-}	TH	Ca^{2+}	Mg^{2+}	Cl^-	DO	COD	Na^+	K^+	NO_3^-	NO_2^-	PO^{3-}_4	Urea	DAP
pH	1																		
EC	0.254	1																	
TU	0.212	0.126	1																
TDS	0.213	0.496	0.064	1															
CO^{3-}	0.241	**0.526***	0.236	0.355	1														
HCO^{3-}	0.431	0.234	0.280	0.056	0.137	1													
TH	-0.296	0.219	0.193	0.038	0.025	0.255	1												
Ca^{2+}	-0.446	-0.095	0.408	-0.130	0.201	0.064	0.05	1											
Mg^{2+}	0.330	0.245	0.126	0.096	0.103	0.131	0.039	**0.687***	1										
Cl^-	0.346	0.148	0.448	0.206	0.073	**0.538***	-0.32	0.421	0.365	1									
DO	0.336	-0.083	0.380	-0.310	-0.28	0.252	0.196	-0.294	-0.09	0.229	1								
COD	0.210	0.489	-0.131	**0.510***	**0.642***	0.251	0.178	-0.073	0.078	0.070	-0.377	1							
Na^+	0.205	-0.057	-0.019	0.274	0.034	0.122	-0.29	0.448	0.304	**0.508***	-0.245	-0.07	1						
K^+	**0.528***	-0.046	0.351	0.279	-0.20	0.324	0.034	0.415	0.162	0.377	0.218	**0.520***	0.07	1					
NO_3^-	0.126	0.077	0.425	-0.395	-0.20	0.324	-0.09	0.095	-0.30	0.399	-0.371	0.163	0.15	-0.08	1				
NO_2^-	-0.257	-0.301	**-0.651***	0.0186	**-0.88***	-0.04	0.018	**0.763***	0.057	-0.71	**-0.693***	0.848	0.38	0.036	-0.096	1			
PO^{3-}_4	0.228	0.354	-0.047	0.242	0.338	-0.23	-0.20	-0.0083	0.397	-0.22	-0.051	0.247	-0.0	0.272	0.285	-0.28	1		
Urea	**0.541***	0.107	-0.187	-0.290	0.037	0.167	**-0.63***	**-0.675***	**-0.52***	0.058	-0.028	-0.36	0.08	-0.34	0.055	**-0.52***	0.470	1	
DAP	0.220	0.360	-0.046	0.256	0.052	-0.23	0.258	0.020	0.403	0.393	-0.231	-0.04	0.23	-0.09	0.265	-0.30	**0.999***	0.467	1
TU- Turbidity, TH-Total Hardness																			

Table-3-Correlation matrix for chemical fertilizers residues with water quality parameters

Statistical analysis: In this study, correlation analysis between various attributes of physico-chemical characteristics with Urea and DAP residues were done and presented in Table 3.

A Correlation analysis is a bivariant method applied to describe the relation between two different parameters. Inter relationship between two parameters was carried out using Pearson correlation. A high correlation co-efficient (near +1 or -1) means a good relation between two variables, and its concentration around zero means no relationship between them at a significant level of 0.05 % level, it can be strongly correlated, if r>0.7, where as r values between 0.5 to 0.7 show moderate correlation between two different parameters.

In water samples, the Urea residues were moderately correlated with pH, total hardness, calcium, magnesium and nitrate. A significant correlation was noticed between DAP and Phosphate, which clearly implies that, phosphate enrichment is mainly due to phosphatic fertilizers. pH is moderately correlated with potassium and urea. Carbonates moderately correlated with COD and strongly correlated with nitrite. Calcium is moderately correlated with magnesium and chloride moderately correlated with sodium. A negative correlation was noticed between DO and nitrite. A strong correlation was noticed between COD and nitrite

From the statistical analysis, it can be concluded that, cations like, calcium, magnesium, potassium and anions like phosphate and nitrate are found to be moderatly correlated with Urea and DAP. In Urea applied soil, nitrate ions were formed as end product after hydrolysis of Urea, which are not strongly adsorbed by the soil particles and will move down through soil profile. The negatively charged nitrate ions will carry positively charged basic cations, such as calcium, magnesium, sodium, and potassium in order to maintain electric charge, on soil particles which will be ultimately leached to ground and surface water.

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