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Research Article

Quantification of Chemical Fertilizers Residues in Soil and Water samples Collected around Agricultural areas of Mysore Taluk, Karnataka, India

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Abstract

Water resources in many parts of the Mysore Taluk are suffering from water quality degradation due to intensive agricultural activities. The nutrients entry into water resources by leaching and surface run-off from agricultural fields helps to assess the impact of Agrochemicals on the aquatic environment. Hence, the present study has been carried out with an objective to assess the effect of chemical fertilizer application in relation to nutrients contamination in surface and ground water resources. During the study, 15 soil samples and 15 water samples were collected from bore wells and lakes around agricultural areas of Mysore Taluk. From the experimental results, it can be observed that,in all the water samples, nitrate and phosphate concentration was found to be higher than the WHO standards. Most of the soil samples were found to be acidic in nature and the depletion of cations was observed. Phosphate level was found to be higher in all the sampling areas, which was due to over-use of phosphate fertilizers. The total nitrogen and nitrate concentrations were found to be higher, compared to the non-agricultural soil samples. From the study, it confirms that, the application of chemical fertilizers has greater influence on soil and water quality.

Keywords: *Urea, DAP, Soil properties, Nitrate, Phosphate, Soil scidity and Cations.*

1. Introduction

Use of chemical fertilizers is considered as a potential source of water pollution problems. Accumulation of high nitrate content in surface and ground water is currently receiving wider attention. A certain portion of nitrate pollution comes from the use of agricultural fertilizers, which can enter directly from the agricultural fields into the surface and ground water resources. Studies on nutrient content in surface and ground water have been widely reported during recent years in many parts of India as well as throughout the world. The effect of irrigation and application of chemical fertilizers can increase the amount of nutrients in water resources. High nutrient content in surface and ground water is usually related to excessive application of chemical fertilizers to crop lands. The major nutrients derived from agricultural activities includes, nitrate, phosphate and potassium. Since nitrate ions are considered as highly mobile through the soil profile, which plays a very dominant role in water pollution resulting from agricultural activities (Hem, *et at*, 1985, Guimera, 1998, Hudak, 2000, Nalan, 2001, Oren, 2004). Apart from nitrate other nutrients such as phosphate and potassium can dissolve and move from the surface through irrigation water towards the water table through the soil profile.

Nitrates are derived from various nitrogenous sources such as, organic manure, human and animal wastes. The process of nitrate formation was governed by various biological processes (Hantzsche, *et al*, 1992). The rate of leaching of these nutrients is influenced by the soil physical and chemical properties and amount of the moisture present within the soil system. Various studies have been conducted on the effect of nitrogen fertilizers applied to soil on water. Several researchers studied the effect of Agrochemicals on ground water quality (Boyer, *et al*, 1995), (Hamilton, *et al*, 1995), (Stuart, *et al.* 1995), (Kacaroglu et al, 1997) and (Kraft, *et al.* 1999). There is a considerable amount of research data showing that, excessive fertilization will not increase crop yields but will only increase nitrogen and phosphorus concentration in surface and ground water.

In India, several studies have reported on groundwater contamination by nitrate due to agricultural activities (Rajmohan, *et al*.1997), (Tamta, *et al*. 1991) and Driescher, et al, 1993 reported that, agricultural land use was one of the sources of phosphorus contamination of an aquifer in the catchment area. A brief study presented above shows that, application of chemical fertilizers to agricultural farm lands had a severe impact on water resources. With this concept the present study is undertaken having the following objectives:
(i) To assess the pollution level of chemical fertilizers in soil and water systems around agricultural areas of Mysore Taluk. (ii) To study the effect of the application of chemical fertilizers and soil properties in connection with water pollution problems, such as nitrate and phosphate enrichment in surface and ground water resources.

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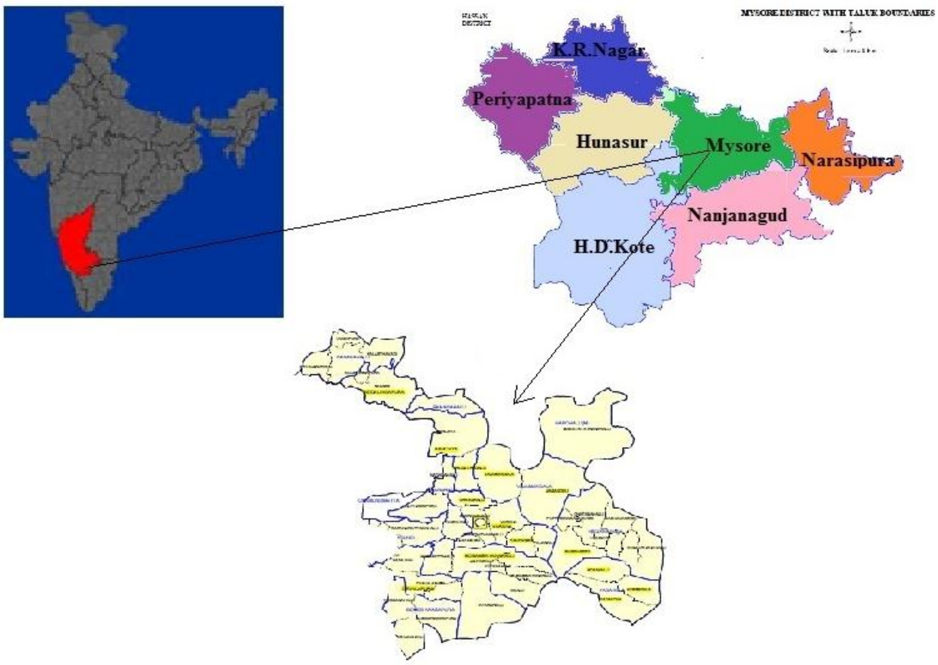


Figure 1-Map of study area

2. Materials and methods

2.1 Brief history of the study area: Mysore Taluk is one of the seven Taluks of Mysore district. It is bounded in the north by Hassan, Mandya & Bangalore districts of the state, in the south by Nilgiris districts of TamilNadu, in the east by Salem & Coimbatore districts of Tamil Nadu and in the west by Coorg districts of the state & the Wyanadu district of Kerala state. The most important economic activity of the study area is agriculture. The total geographical area of Mysore Taluk covers about 81,740 hectares, out of which 38,600 ha of land is used for agricultural purpose. The study area receives an annual rainfall of 798 mm from the South-west monsoon. The agricultural operation is dependent mostly on canal irrigation due to perennial streams or rivers in the Taluk. Red soil, black soil and clay soil are found in Mysore Taluk. Major crops grown are paddy, Ragi, Jawar, pulses, groundnut, fruits, vegetables & Oil Seeds.

2.2 Land use patterns and agricultural activity: The agricultural lands cover most of the area in Mysore taluk. The main cropping season is from September to January. During this period, the river and groundwater are used for irrigation. The second cropping season is from February to May when paddy, vegetables, pulses and groundnut are grown. These crops are mainly dependent on lake/pond water and groundwater. Rice and other crops are sometimes grown in some parts of the area, from May to September which are mainly dependent on groundwater. The most commonly used fertilizers for paddy in this site are urea, NPK complex (20-0-20), diammonium phosphate and muriate of potash (KCl) during farming season. The recommended rate of nitrogen fertilizer application is 100-120 kg for paddy, 160 kg N/ha for sugarcane (per year) and 40– 100 kg N/ha for other crops. The amount of chemical fertilizers used varies within the study area, depending on the type of crop and the actual rate of application varies, depending on the farmer's practice.
The description about sampling place, cropping pattern, fertilizer type and quantity applied in study area are presented in Table-I

2.3 Collection of soil samples: 15 soil samples were collected from selected agricultural areas from different farmlands and non- agricultural lands. From each of the farm lands, composite soil samples were collected along with one sample from non-agricultural land. The soil samples were collected at 0-15 cm depth, air dried, ground and sieved through a 2 mm sieve and stored in polythene bags until analysis. The physico-chemical analyses were carried out as per standard methodology of Arun Kumar Saha (2008), GKVK manual (1999) and methods of analysis for soils, plants and waters (Chapman and Pratt, 1961).

2.4 Analysis of Soil Samples: The soil moisture content was assessed by gravimetric method. The bulk density and particle density were determined by core sampler method and volumetric flask method. The urea residues were quantified by reaction of urea with diacetylmonoxime under acidic condition using a spectrophotometer. The diammonium phosphate residues were calculated by using the amount of phosphate (taking difference between agricultural and non-agricultural soil samples) present in soil samples, considering the molecular weight of a DAP and weight of a phosphate group of DAP. The soil pH was measured in 1:5 soil/water suspensions using the glass electrode pH meter. The electrical conductivity of the soil extract was determined by using conductivity meter. The organic carbon was determined by using potassium dichromate oxidation method. The total nitrogen was

Table-1: Sampling points with sampling codes, crop types and types of fertilizers applied for agricultural lands.

Sl No	Sampling stations of soil water	Types of crops cultivated	Types of fertilizers used	Water source	Quantity of	
					urea applied	DAP applied
1	Siddlingapura	Sugar cane, Paddy	Urea, DAP	Bore well	100 kg/ha	50 kg/ha
2	Hanchya	Ragi, and paddy	Urea , 20-0-20, DAP	Bore well	100 kg/ha	50 kg/ha
3	Bugathgalli	Mulberry cultivation	Organic manure, Urea	Bore well	100 kg/ha	50 kg/ha
4	Chikkahalli	Ragi, Paddy, Maize	Urea, Organic manure, 20-0-20	Bore well	100 kg/ha	50 kg/ha
5	Mosaimbayanahalli	Ragi, Paddy, Maize	Urea, Organic manure, 20-0-20	Lake water	100 kg/ha	50 kg/ha
6	Dandikere	Paddy, Ragi	Urea, Organic manure	Bore well	100 kg/ha	50 kg/ha
7	Varuna	Paddy, Ground nut	Urea, 20-0-20	Lake water	100 kg/ha	50 kg/ha
8	Vajmangala	Areca nut, Banana	DAP, Urea	Lake water	100 kg/ha	50 kg/ha
9	Varakodu	Leguminous plants	Organic manure, 20-0-20	Bore well	100 kg/ha	50 kg/ha
10	Duddgere	Ragi, Paddy	Urea, 20-0-20	Bore well	100 kg/ha	50 kg/ha
11	Megalpura	Sugar cane	DAP, Organic manure	Bore well	100 kg/ha	50 kg/ha
12	Hossahalli	Sugarcane	DAP, Organic manure	Bore well	100 kg/ha	50 kg/ha
13	Kuppegala	Ragi, Sugarcane	DAP, Organic manure	Bore well	100 kg/ha	50 kg/ha
14	Yadakola	Ragi, paddy	Urea, DAP, 20-0-20	Bore well	100 kg/ha	50 kg/ha
15	Devalapura	Paddy, Ragi	Urea, DAP ,20-0-20	Lake water	100 kg/ha	50 kg/ha

determined by Kjeldhal distillation method, while the phosphate was determined by o-dianisidine molybdate method. The sodium and potassium concentrations were determined by flame photometry. Estimation of calcium and magnesium was done by EDTA titration method and the ammoniacal nitrogen by Nessler's reagent method.

2.5 Collection of water samples: Fifteen water samples were collected from selected agricultural lands of Mysore district, which includes ground water, lake water. Water samples were collected in clean polyethylene bottles. The sampling bottles were soaked in the 1:1 dilute HCl solution for 24 h, washed three times with deionized water, and were washed again prior to each sampling with the filtrates. In case of bore wells, the water samples were collected after pumping the water for 10 min. Samples collected were transported to the laboratory on the same day, and filtered and acidified with ultra-pure nitric acid for cation analyses. For anion analyses, these samples were stored below 4^0C. The samples were analyzed for nutrients and major ions, according to the procedure given in APHA (1989).

2.6 Analysis of water samples: The urea residues were quantified by diacetyl monoxime method and diammonium phosphate residues were calculated by using the amount of phosphate present in the 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 the standard EDTA method, sodium and potassium were determined by flame photometric method, chloride was determined by the argentometric titration method. Nitrate was determined by the phenoldisulphonic acid method.

Results and Discussion

3. Soil samples

The results obtained from the analysis of soil and water samples from Mysore Taluk of Mysore district are shown in Tables 2 and 3. Standard methods have been employed for the analysis of chemical fertilizer residues, along with physico- chemical characteristics of soil and water samples. A comparison of the physico-chemical characteristics has been made with WHO drinking water quality standards. Following observations were made from different characteristics.

3.1 Moisture content: During the present investigation, the moisture content values in Mysore Taluk ranged from 13.04 to 36.11 % In case of non-agricultural soil samples, the moisture content was found to be 12.36 %. The Highest value was recorded in S (15). The variation in moisture content depends on the amount of pore space present in soil, which is related to soil texture.

*3.2 Bulk density***:** Bulk density is defined as the mass of soil material present per unit volume of moist soil under natural undisturbed condition. The bulk density of clay and clay loam soil normally ranges from 1 to 1.65 mg/m^3. During the present study, the variation of bulk density values ranged from 0.94 to 1.26 mg/m^3. In case of non-agricultural soil samples, the bulk density was found to be 1.08 mg/m^3. Lowest bulk density was reported in S (14) and highest in S (1). Bulk density is related to total porosity, or pore space present in the soil for air and water movement (Mini *et al*, 2003: Tester, 1993). Lower bulk density implies greater pore space and improved aeration, developing a suitable environment for biological activity (Werner, 1997).

3.3 Particle density: Particle density is the density of solid particles in a particular sample. During the present study, the particle density of soil samples ranged from 2 to 5 mg/m^3. Normally the particle density ranges from 2 to 2.65 mg/m^3, which indicates the presence of clay and

Table 2 Physico- chemical characteristics of water samples collected around agricultural areas of Mysore Taluk

Parameters	**WHO Stds Desirable limits**	**W-1**	**W-2**	**W-3**	**W-4**	**W-5**	**W-6**	**W-7**	**W-8**	**W-9**	**W-10**	**W-11**	**W-12**	**W-13**	**W-14**	**W-15**
		B	**B**	**B**	**B**	**L**	**B**	**L**	**L**	**B**	**B**	**B**	**B**	**B**	**B**	**L**
Urea Residues		2.3	Nil	0.8	0.6	1.1	2.8	Nil	Nil	Nil	Nil	NIl	2.8	0.18	1.6	0.17
DAP Residues		4.44	4.17	5.42	3.05	3.75	3.05	3.61	3.89	2.78	3.33	3.89	3.33	3.75	2.5	2.92
pH	7-8.5	7.43	7.49	7.25	7.09	8.51	8.78	7.92	8.75	7.19	8.92	8.88	8.67	8.97	7.78	8.02
Conductivity	2500	960	1680	980	1330	540	560	280	500	1470	770	1380	650	870	750	600
TDS	500	620	860	520	910	320	220	140	180	750	560	880	380	420	390	480
Carbonates	50	130.8	152.6	109	152.6	109	87.4	65.4	130.8	109	165.5	610.4	109	43.6	65.4	392.4
Bicarbonates	500	675.8	392.4	566.8	457.8	414.2	327	130.8	261.8	152.6	436	828.4	233.8	566.8	392.4	784.8
T. Hardness	500	680.54	820.25	1020.8	680.54	300.24	440.35	170.13	280.22	920.73	350.28	580.4	400.3	600.48	420.33	290.23
Calcium	100	172.34	208.41	180.36	68.136	20.04	72.14	24.04	64.12	196..39	48.09	56.11	92.18	72.14	80.16	64.12
Magnesium	150	50.82	162	80.45	42.42	80.2	38.21	40.1	26.1	70.34	32.19	30.35	38.14	52..34	40.17	26.11
Chloride	250-1000	1470.4	1044.8	2050.8	773.9	309.56	386.95	349.25	232.17	1431.7	309.56	1199.5	425.6	503.03	309.56	232.12
DO	6	6.56	7.43	8.32	6.32	7.32	7.23	8.1	6.78	7.01	7.67	7.21	6.45	8.41	8.23	7.45
COD	10	14.78	13.23	14.28	12.09	10.53	10.23	14.28	11.67	16.08	13.12	10.32	10.09	20.08	12.36	11.43
Sodium	200	440	540	660	390	200	370	100	220	240	500	680	400	320	290	470
Potassium	12	12	22	12	16	60	11	60	60	17	90	14	22	11	70	80
Nitrate	50	1650	1400	770	390	240	160	40	80	790	100	550	170	160	440	540
Nitrite	0.02	1.6	1	1.4	0.3	1.1	1.5	2.1	1.2	0.6	0.6	0.9	1.3	1.9	1,8	2.1
Phosphate	0.1	2.6	5.9	7.2	5.1	2.9	3.1	2.6	6.3	4.2	5.1	4.2	5.1	3.6	4.7	5.3

B- Bore well water samples, **L**- Lake water samples,

Note – All the units are expressed in mg/l, except pH, temperature (^oC), conductivity ((mmhos/cm)

quartz minerals in the soil matrix. High particle density indicates, the presence of rich iron in soils ex: ferromagnesian mineral density range from 2.9 to 3.5 mg/m^3 and the density of iron oxides and other heavy minerals can exceed 5 mg/m^3.[3.]

3.4 Porosity or pore space: Porosity or pore space of a soil is that portion of the total soil volume, which is not occupied by solid particles but occupied by air or water. During present investigation, the porosity values ranged from 53-79.2 %. The highest value was recorded in S (3) and lowest in S (14). In case of non-agricultural land soil samples, the porosity value was found to be 78.4 %. The pore space of a soil varies with respect to soil texture, shape of individual soil particles, organic carbon content and nature of crop soil management.

Table 3 Physical characteristics of soil samples collected around agricultural areas of Mysore Taluk

Parameters	**Normal range**	NAS	**S-1**	**S-2**	**S-3**	**S-4**	**S-5**	**S-6**	**S-7**	**S-8**	**S-9**	**S-10**	**S-11**	**S-12**	**S-13**	**S-14**	**S-15**
Urea Residues ppm			1.2	0.4	0.6	0.2	3.2	4.1	1.4	2.8	1.3	4.2	0.9	1.3	1.6	4.3	3.7
DAP Residues ppm			14	10.1	16.4	9.45	10.14	11.26	6.39	12.7	8.06	18.3	9.87	22.5	12.6	14.7	13.76
Moisture content %		12.4	16.7	24.3	16.3	15.9	13.6	14.7	19	13	21.4	18.2	26.8	15.2	25.6	32.4	36.1
Bulk density mg/m^3	1-1.65	1.08	1.26	1.22	1.04	1.03	1.18	1.16	1.06	0.98	1.08	0.98	0.98	1.12	1.1	0.94	0.96
Particle density mg/m^3	2-2.65	5	2	3.33	5	3.33	3.33	2.5	3.33	2.5	5	2.5	2.5	3.33	2.5	2	3.33
Porosity %	30-55	78.4	2	3.33	5	3.33	3.33	2.5	3.33	2.5	5	2.5	2.5	3.33	2.5	2	3.33
pH	6.5-7.5	7.4	8.1	7.2	7.5	7.1	7	7.2	7.9	8.1	4.5	5.8	7.6	7.6	7.6	7.7	7.5
Conductivity	0-2	0.2	0.3	0.2	0.3	0.2	0.2	0.3	0.6	0.2	0.4	1	0.3	0.3	0.3	0.1	0.1
Calcium	10-30	15.3	4.6	3.8	2.8	2.5	2.6	5.2	1.8	3.9	4.6	3.9	5.2	2.8	7.2	3.1	2.7
Magnesium	05-10	8.1	1.5	1.4	1.4	1.5	3.9	3.6	1	2.9	2.7	4.1	4.6	1.5	5	2.2	2.2
Organic carbon %	0.50-0.75	1.52	0.54	0.99	0.81	2.28	2.61	1.98	2.7	2.29	0.45	1.89	2.16	1.62	2.1	1.83	2.43
Chloride %	0.020-0.120	0.035	0.028	0.049	0.021	0.042	0.014	0.125	0.049	0.063	0.078	0.113	0.994	0.056	0.142	0.071	0.028
Total nitrogen Kg/ha	200-500	136.2	313.6	940.8	1176	940.8	1077	1256	627.2	705.6	864.4	940.8	627.2	1332	1176	940.8	1646
Nitrate Kg/ha	-	12.4	36	29.1	103	56	44.8	52.6	29.6	71.7	28.3	31.4	53	35.8	62.7	38.1	41
Sodium Kg/ha	-	51.7	109	48	51	74	45	48.6	71	58	64	87	41	24	84	78	78
Potassium Kg/ha	50-125	33.1	45	39	42	56	26	29.2	20	24	43	34	22	19	45	42	49
Phosphate ppm		9.1	10.1	7.3	11.8	6.8	7.3	8.1	4.6	9.2	5.8	13.2	7.1	16.2	9.1	10.6	9.9

NAS- Non agricultural soil sample

*3.5 Urea***:** During the present study, the urea residues ranged from 0.2 to 4.3 ppm. Generally, when urea is applied to soil, it is hydrolyzed rapidly to ammonia and carbon dioxide by soil Urease enzymes. The rate of degradation depends on soil pH, temperature, moisture content, organic carbon, quantity of urea applied (Bremner and Mulvaney, 1978).

3.6 Diammonium phosphate residues (DAP): During the present study, the DAP residues in soil samples, ranged from 6.39 to 22.5 ppm. The highest concentration was reported in S (12) and lowest in S (7). High concentration of DAP residues indicates that, the quantity of fertilizer applied to the soil has not been completely utilized by the crops.

3.7 pH: During the present study, variation of pH was noticed from a minimum of 4.50 to a maximum of 8.12. For non- agricultural soil sample, the pH was found to be 7.4. According to the present investigation, S (9), (10)

Table 4 Correlation matrix between Chemical fertilizer residues and Soil properties with selected water quality parameters

	Urea	**DAP**	**pH**	**EC**	**Ca^{2+}**	**Mg^{2+}**	**OC**	**Cl^-**	**NO_3^-**	**Na^+**	**K^+**	**pH**	**EC**	**TDS**	**DO**	**COD**	**Na^+**	**K^+**	**NO_3^-**	**PO_4^{3-}**
Urea	**1**																			
DAP	0.23	**1**																		
pH	-0.06	0.13	**1**																	
EC	0.2	0.15	-0.43	**1**																
Ca^{2+}	-0	0.055	-0.1	0.009	**1**															
Mg^{2+}	0.39	0.02	0.21	0.18	**0.69**	**1**														
OC	0.39	0.19	0.35	0.01	-0.2	0.32	**1**													
Cl^-	0.26	0.02	-0.22	0.37	0.76	0.7	0.12	**1**												
NO_3^-	**0.68**	0.14	0.317	-0.2	0.1	0.097	0.063	-0.06	**1**											
Na^+	0.22	0.36	0	0.24	0.17	-0.02	0.11	0.05	0.17	**1**										
K^+	0.13	-0.08	0.21	0.24	0.1	-0.17	0.33	-0.12	0.1	**0.6**	**1**									
pH	0.48	0.275	0.187	0.251	0.4	0.741	**0.55**	**0.6**	0.01	-0.24	**-0.61**	**1**								
EC	**-0.61**	0.231	-0.4	-0.19	0.28	-0.03	**-0.58**	0.036	0.05	0.058	0.439	-0.4	**1**							
TDS	**-0.56**	-0.14	0.367	-0.12	0.14	-0.04	-0.43	0.055	-0.01	0.059	0.497	0.44	**0.93**	**1**						
DO	0.23	-0.05	0.07	0.23	0.1	-0.2	0.12	0.24	0.23	0.16	0.04	0.1	0.2	0.3	**1**					
COD	-0.3	0.169	0.191	0.205	0.48	0.101	-0.34	0.28	0.077	**0.55**	0.44	-0.2	0.2	0.08	0.45	**1**				
Na^+	-0.27	0.36	0.048	-0.03	0.17	0.048	-0.35	0.016	0.321	-0.13	0.204	0.24	**0.51**	**0.61**	0.03	-0.15	**1**			
K^+	**0.7**	0.14	-0.02	0.337	-0.4	0.05	**0.5**	0.135	-0.3	0.237	-0.14	0.24	**0.54**	**-0.4**	0.24	-0.25	0.3	**1**		
NO_3^-	**0.55**	-0.08	0	-0.32	0.09	0.397	**0.76**	-0.39	-0.31	0.257	0.44	**-0.6**	**0.62**	**0.59**	0.18	0.192	0.36	0.42	**1**	
PO_4^{3-}	0.23	**1**	0.131	0.154	0.05	0.048	0.187	0.018	0.14	0.085	0.071	0.27	0.2	0.15	0.05	-0.17	0.35	0.14	0.08	**1**

were found to be acidic in nature. Except, S (1), S (7), S (11), S (12), S (13) and S (14) rest of the soil samples were found to be within the normal range. Long term fertilizer application of nitrogen and phosphorous fertilizers results in low soil pH, which confirms the findings of Aref and Wander *et al* (1998).

3.8 Electrical conductivity (EC): Electrical conductivity determines the amount of salts present in soil suspension. During the present investigation, the EC ranged from 0.12 to 1.04 dS/m For non-agricultural soil sample, the EC was found to be 0.18 dS/m. The value of electrical conductivity was from zero to 2 dS/m, which is safe for all the crops. During the present investigation, the EC values for all the soil samples were found to be within the normal range, reflecting that, all the soil samples have a safe range of electrical conductivity.

3.9 Calcium and magnesium: The calcium and magnesium concentrations in Mysore Taluk ranged from 1.8 to 7.2 meq/l and 1.0 to 5.0 meq/l. In case of non- agricultural soil samples, calcium and magnesium were found to be from 15.3 and 8.1 meq/l. In comparison with the non-agricultural soil samples, the calcium and magnesium concentrations were found to be very less. For urea applied soils, nitrate ions were formed as an end product after hydrolysis of urea which is not strongly adsorbed by the soil particles which will move down through the soil profile. The negatively charged nitrate ions carry positively charged basic cations, such as calcium, magnesium, sodium, potassium in order to maintain the electrical charge on the soil particles. The depletion of these basic cations will accelerate the acidification process in soil which is another reason for decrease in soil pH and confirms the findings of Nel *et al* (1996).

3.10 Organic carbon: Organic carbon is an index of soil productivity. During the present investigation, the organic carbon concentration was found to be 0.54 to 2.61 %. In non-agricultural soil samples, the organic carbons were found to be 1.52 %. For all the soil samples, except S (9) the organic carbon was found to be higher compared to the normal range. The high organic carbon is due to accumulation of crop residues on the soil surface (Ashok, 1998).

3.11 Total nitrogen: The total nitrogen content for all the soil samples were found to be higher in the range. The total nitrogen values ranged from 313.6 to 1646.4 kg/ha. In case of non-agricultural soil, the value was found to be 136.2 kg/ha. Except, non-agricultural soil samples, total nitrogen in all the agricultural soil samples was found to be high, which is due to excessive application of nitrogenous fertilizers and also through leguminous crop rotation (Nel *et al*, 1996).

3.12 Nitrate: The nitrate concentration in Mysore Taluk, varied from 1.79 to 27.68 kg/ha. In comparison to the non-agricultural soil sample, the nitrate concentrations in all the agricultural soil samples were found to be higher, which mainly depends on moisture content and enzymatic activity of soil system which may vary from one place to another (Bremner *et al*, 1978).

3.13 Sodium and potassium: Sodium and potassium are important basic cations, which are considered as indicators of nutritional imbalance**.** During the present study, the sodium and potassium concentrations in Mysore Taluk, ranged from 24 to 109 kg/ha. In case of non- agricultural soil samples the sodium and potassium concentrations were found to be 23.1 and 14.8 kg/ha respectively. In comparison with concentrations of non-agricultural soil samples, the sodium and potassium concentrations were found to be very less. This confirms the findings of Nel et al (1996) that, his experiments on long term application of different types of chemical fertilizers on soil, resulted in the decline of basic cations.

4. Water samples

4.1 Urea: During the present study, the urea residues ranged from 0.6 to 2.8 ppm. The minimum and maximum concentration of urea residues was recorded in bore well water samples W (4) and W (12) respectively. In case of water samples W (2), (7), (8), (9), (10), (11) urea residues was not recorded. This implies that, the quantity of urea residues entered to water resource may completely hydrolyzed.

4.2 Diammonium phosphate residues (DAP): During the present study, the DAP residues in soil samples, ranged from 2.50 to 5.42 ppm. The highest concentration was reported in W (14) and lowest in W (3). High concentration of DAP residues indicates that, the quantity of fertilizer applied to the soil has not been completely utilized by the crops. Due to process of leaching through the soil profile, the DAP residues was recorded higher in bore well water samples.

4.3 pH: pH is the measure of acidity or alkalinity of water. During the present study, pH of water samples ranged from a minimum of 7.09 (lake water) to a maximum of 8.97(bore well). During the present investigation, the variation in pH was observed. Except in W (4), (8), (10), (11), (12) and (13) rest of the water samples were found to be within the permissible limits of WHO standards. The results also show that, the alkaline pH is particularly due to the presence of cations like calcium, magnesium and sodium. This was in conformity with the findings of Azeez *et.al* (2000).

4.4 Electrical conductivity (EC): Electrical conductivity is the measure 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 samples ranged from a minimum of 280 (lake water) to a maximum of 1680 dS/m (bore well). The EC values in all the water samples were found to be within the permissible limits of WHO Standards.

4.5 Total dissolved solids (TDS): The total dissolved solids indicate the nature of water quality. During the present investigation, the TDS values in water samples ranged from a minimum of 440 mg/l (lake water) to a maximum of 910 mg/l (bore well). The desirable limit of TDS in water samples was up to 500 mg/l. In water samples (1), (2), (3), (4), (7), (9), (10), (11) TDS was found to be slightly higher than the desirable range. The TDS concentration up to 1000 mg/l is permissible for drinking and agricultural purposes. From the present study, it can be concluded that, the water can be used for agricultural and drinking purpose.

4.6 Carbonates and bicarbonates: Alkalinity of water is the capacity to neutralize a strong acid in a solution. During the present investigation, the carbonate values ranged from a minimum of 43.6 (bore well) to a maximum of 610.4 mg/l (lake water) and 130.8 (lake water) to a maximum of 828.4 mg/l (bore well) respectively. In the present study, all the water sample carbonate concentration was found to be higher, except samples (13). Similarly, in case of bicarbonates high values were reported in water samples (1), (3), (7), (11), (13), (15), which is normally due to the presence of carbonates, bicarbonates and hydroxides of calcium and magnesium.

4.7 Total Hardness: Total hardness in the water mainly depends on the amount of calcium and magnesium present in any natural water. The desirable limit for total hardness in water samples is 500 mg/l. During the present investigation, the total hardness in water samples, ranged from 170.13 (lake water) to 1020.8 mg/l (ground water)l. High total hardness was reported in water samples (1), (2), (3), (4), (9), (11) and (13).

4.8 Calcium and magnesium: Calcium and magnesium are directly related to the hardness of water. The calcium and magnesium concentration ranged from, a minimum of 20.04 (lake water) to a maximum of 208.41 mg/l (bore well) and 26.1(lake water) to 162 mg/l (bore well) respectively. The high at concentration of calcium and magnesium of the above water samples was due to the dissolution of limestone. During the present investigation, except samples (1), (2), (3), (9) for all other water samples, calcium was found to be within WHO standards. In all the water samples, magnesium concentration was found to be within the permissible limits of WHO standards

4.9 Chloride: Chloride 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 chlorides from chloride containing rocks. During the present study, the chloride values ranged from a minimum of 232.1 (lake water) to a maximum of 2050.83 mg/l (bore well). Except samples, (1), (2), (3), (9),(11) in all the water samples, chloride concentrations were found to be within the permissible limits.

4.10 Dissolved oxygen (DO): During the present investigation, the dissolved oxygen in water samples was, from a minimum of 6.32 (bore well) to a maximum of 8.41 mg/l (bore well). 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 for water samples.

4.11 Chemical oxygen demand (COD): Chemical oxygen demand determines the oxygen required for chemical oxidation of organic matter. During the present study, we have observed the variation in COD values from a minimum of 10.04 (bore well) to a maximum of 20.08 mg/l (bore well). 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.

4.12 Sodium and potassium: The sodium and potassium concentrations range from a minimum of 100 to a maximum of 680 mg/l and 11 to 90 mg/l respectively. Except samples (5), (7) for all the water samples, sodium concentration was found to be above the permissible limits. Except sample W (13) for all the water samples potassium concentration was found to be above the permissible limits. In Ground water and surface water, the potassium contamination can result from the application of potassium fertilizers greater than the required concentration. Potassium leaching from the soil is important from the perspective of plant nutrition. If the fertilizer use and application to irrigation water exceeds the crop requirement, water will carry excess with it, soluble salts including potassium, which implies, enrichment of potassium in surface and ground waters due to influence of urea fertilizers.

4.13 Nitrate: The nitrate concentration in water samples varied from a minimum of 40 (lake water) to a maximum of 1650 mg/l (bore well). In all the water samples, nitrate concentration was found to be above the permissible limits. During irrigation, urea is generally used as a source of nitrogen for paddy and other crops. In the soil, when urea is applied, it gets transformed to ammonium ion (NH_4^+) by soil enzymes, which tends to be stronger, adsorbed on soil particles. This adsorption inhibits the movement of ammonium ions through the soil. Ammonium ion is energy rich and certain soil bacteria can utilize this energy by decomposing the ammonium ion to nitrate (NO_3^-). Unlike ammonium ion, nitrate ion is not adsorbed on soil particles and therefore, moves readily with water in the soil. Nitrate, which is not taken up by plant roots or soil micro-organisms, can be transported to ground and surface water by a variety of mechanisms.

4.14 Phosphate: In contrast to nitrate, phosphate is strongly adsorbed by soil colloids, which greatly retards its downward movement. Usually, surface and ground water contains a minute phosphorous level, because of the low solubility of native phosphate minerals and also due to high retention capacity of soils to retain phosphate. The phosphate content in the study area was from a minimum of 2.6 to a maximum of 7.2 mg/l. Highest phosphate concentration was reported in W(2) (bore well water). In the present studied area, intensive crop productions, continuous application of phosphate fertilizers and farmyard manure have been used at levels exceeding crop requirements. Highest phosphate concentration indicated that, diammonium phosphate is the major source of enrichment of phosphate in water samples.

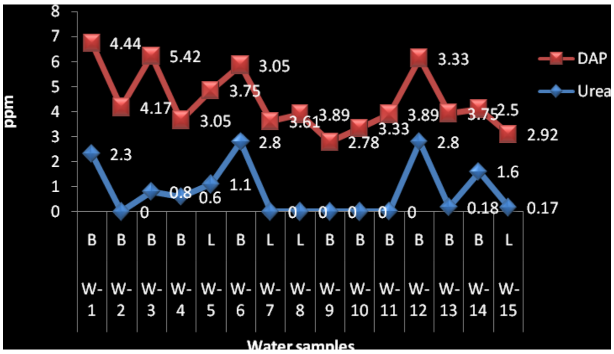
5. Statistical analysis: In the present study, correlation analysis between various attributes of physical and chemical parameters of soil and water along with Urea and DAP residues were done and presented in Table 4.

A Correlation analysis is a bivariant method applied to describe the relation between two different parameters. Interrelationship 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 % which can be strongly correlated, if r>0.7, whereas, r values between 0.5 to 0.7 show moderate correlation between two different parameters.

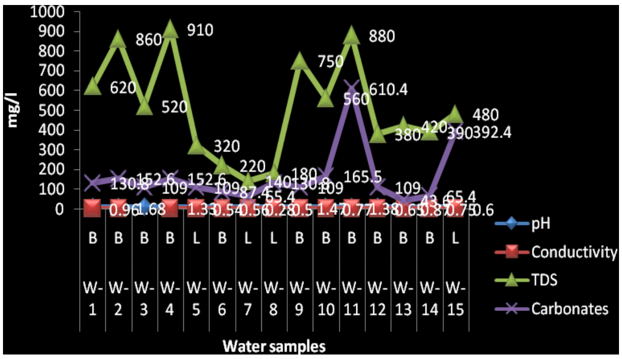
A correlation study between chemical fertilizer residues, chemical characteristics with selected water quality parameters shows that, urea is moderately correlated with nitrate of soil. This indicates that, accumulation of nitrate in the soil is mainly as a byproduct of urea hydrolysis. Moderately correlated with TDS, EC and nitrate. Urea is strongly correlated with potassium in water samples. Calcium moderately correlated with pH and EC and strongly correlated with nitrate, potassium, Magnesium is strongly correlated with pH, Sodium moderately correlated with COD. Chloride in soil moderately correlated with pH. Sodium moderately correlated with potassium and COD. pH of water sample moderately correlated with nitrate. EC moderately correlated with TDS, sodium, potassium and nitrate.

From the statistical analysis, it can be concluded that, application of chemical fertilizers has severe impact on physical parameters of soil such as, bulk density, porosity, which in turn related to leaching of cations from the soil. These cations such as, calcium, magnesium, potassium and anions like phosphate and nitrate are found to be highly correlated with Urea and DAP. Some of the soil properties such as, organic carbon slightly influence the water quality such as COD, potassium, nitrate, pH and EC of the water. Chloride in soil is moderately correlated with Urea applied soil, nitrate ions were formed as end products after hydrolysis of Urea, which are not strongly adsorbed by the soil particles and will move down through the 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 into ground and surface water.

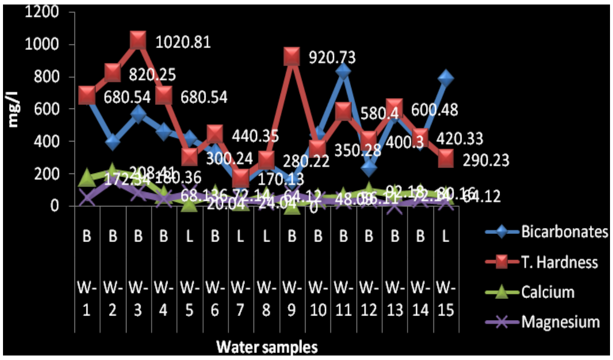
6. Graphical representaion of Variations in chemical fertilizer residues and physico-chemical characteristics of soil and water samples.



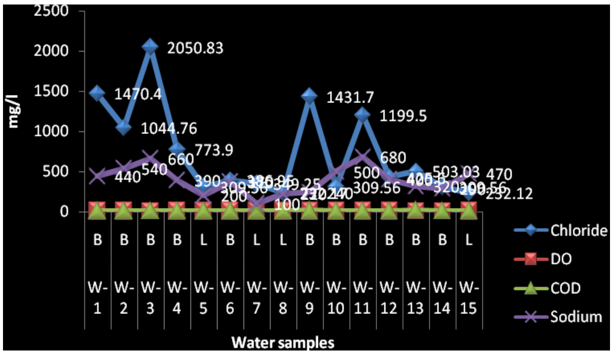
Graph- 1 Variation of Urea and DAP in different water samples



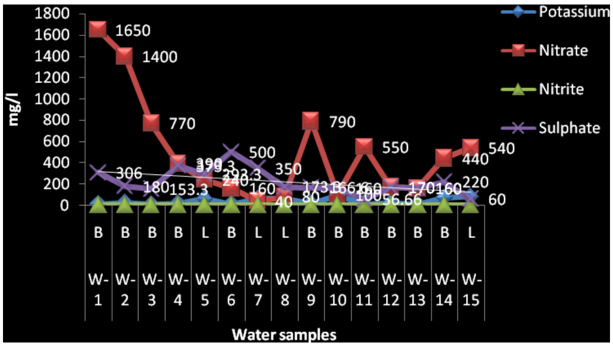
Graph-2 Variation of pH, Conductivity, TDS and Carbonates in different water samples



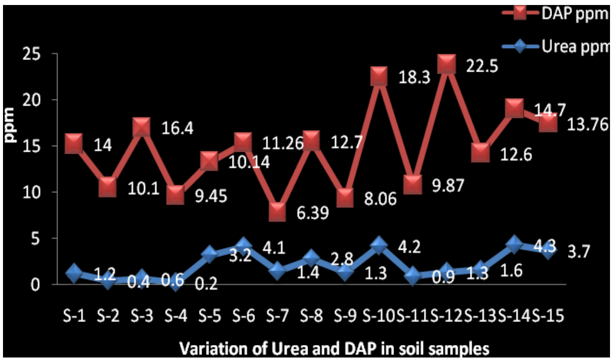
Graph- 3 Variation of Bicarbonates, Total Hardness, Calcium and Magnesium in different water samples



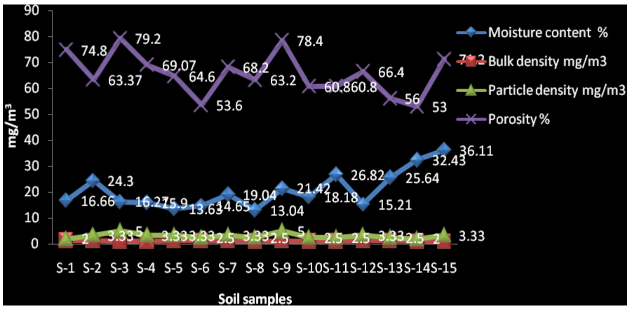
Graph-4 Variation of Chloride, Dissolved oxygen, Chemical oxygen demand and Sodium in different water samples



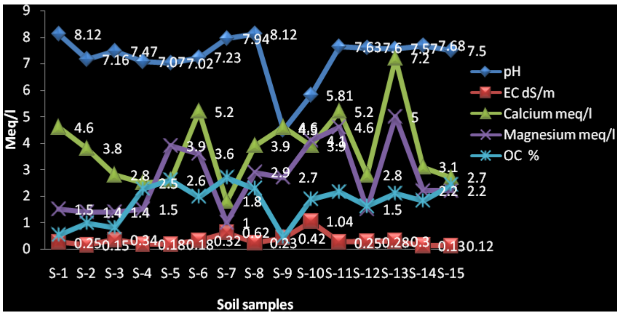
Graph-5 Variation of Potassium, Nitrate, Nitrite and Sulphate, in different water samples



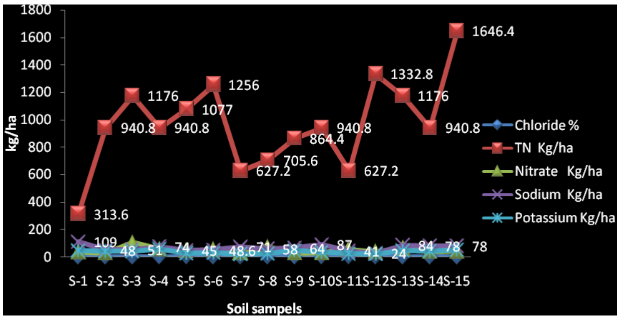
Graph- 1 Variation of Urea and DAP in different Soil samples



Graph-6 Variation of Soil Physical properties in different soil samples



Graph-7 Variation of pH, Conductivity, Calcium, Magnesium and Organic carbon in different soil samples



Graph-8 Variation of pH, Chloride, Total nitrogen, Nitrate, Sodium and Potassium in different soil samples

Conclusion

1. The influence of soil properties on the pH, EC, phosphate and nitrate leaching with the application of chemical fertilizers was studied.
2. The results suggest that, soil pH and texture were the relevant soil properties controlling the leaching of nutrients from agricultural lands.
3. For the present study; it confirms that, the application of chemical fertilizers has greater influence on soil and water quality. Most of the soil samples were found to be acidic in nature and the ions like calcium, magnesium, sodium and potassium were found to be reduced.
4. Phosphate level was found to be higher in all the sampling areas, which was due to over-use of phosphate fertilizers.
5. The total nitrogen, were found to be higher, compared to the non-agricultural soil samples. In case of water samples, high nitrate and phosphate concentration is a major problem.
6. One can recommend that, continuous efforts should be made to advise the farmers about the proportionate use of chemical fertilizers with respect to crop requirements, restricting the application of chemical fertilizers, splitting of fertilizer dose at required concentration, will help to reduce pollution of surface and ground water.

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