The Comparative Studies on Seasonal Variations of Chemical Fertilizer Residues and Physico-Chemical Characteristics in Different Water Samples

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ABSTRACT

The application of chemical fertilizers for food production has continuously increased globally since mid 20th century. The introduction of modern high yielding varieties and development of irrigation facilities during 1960's, consumption of chemical fertilizers increased markedly. Chemical fertilizers are applied to soil in order to increase the level of nutrients available in the soil. The present study comprises investigation of chemical fertilizer residues along with physio-chemical characteristics in different water samples with respect to seasons. A comparative study has been made in order to assess the fertilizer pollution levels and their impact on different water resources. The seasonal investigations shows, higher concentration of chemical fertilizer residues during rainy season. The conductivity values were found to be slightly above the desirable limits of WHO standards. In all the seasons, Calcium, Potassium, Nitrate and Phosphate concentrations were found to be higher compared to WHO standards. The present study implies that, compared to bore well water, channel water samples were susceptible for fertilizer pollution during rainy season.

Key Words: *Channel water, Bore well water, Chemical fertilizers, Seasons.*

Introduction

Water pollution has become a growing concern in the recent decades. Assessment of seasonal changes in water quality is important for evaluating variations of water pollution [1, 2]. Among the inorganic fertilizers, use of nitrate and phosphate fertilizers had led to excessive contamination of surface and ground waters. The fate of nitrogen fertilizers in the soil environment is controlled by several physical, chemical and biological factors that interact with each other [3]. The main processes affecting the fate of fertilizers in the soil are immobilization, adsorption and fixation, leaching to ground water. Phosphate, sulphate, nitrate and chloride are the major anions added to soil through fertilizer addition [5, 6, 7]. Some of these anions are implicated in the contamination of surface and ground water resulting in eutrophication of water bodies. Anions in soils are generally grouped into reactive and non reactive anions [8]. This is mainly based on the extent of adsorption of anions onto the soil particles. Traditionally phosphate and sulphate are included in the reactive group, nitrate and chloride in the non reactive group. The reactivity of anions influences their persistence and mobility in soils. Many researchers show that, agricultural practices can cause pollution of water bodies and, over time, cumulative effects can lead to

the depletion of water quality [9, 10, 11]. In this study, an attempt has been made to study the seasonal variations of physico-chemical characteristics of surface water around agricultural areas of Hunsur taluk.

Materials and Methods

Description of the Study area:

Hunsur Taluk is one of the seven talukas in the district. Hunsur is located at 12.31°N 76.29°E. It has an average elevation of 792 meters (2598 feet). The river Lakshmana Tirtha flows though the town. Red, gravelly, black and clay soils are found in Hunsur taluk. Actual rainfall of Hunsur taluk was 742.9 mm. The total geographical area is about 98194 ha out of which 64870 ha of land is used for agricultural purpose. The agricultural lands cover most of the area. The main cropping season is from September to January. During this period, Paddy and vegetables are grown. These crops mainly depend on bore well, river and channel water sources, used for irrigation throughout all the seasons. The second cropping season is from February to May. Tobacco, maize, turmeric, vegetables, cotton, banana, green leafy vegetables are grown. These crops are mainly dependent on channel water. Tobacco and maize are the major crops grown in majority of the area, throughout the year. The most commonly used fertilizers are urea and diammonium phosphate during farming season. 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, which may exceed the prescribed rate.

Collection of water samples:

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

Experimental procedure for the analysis of water samples:

The urea residues were quantified by diacetyl monoxime method. 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. The pH and EC were measured by using pH and conductivity meters. 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.

Table 1: Seasonal variations of chemical fertilizer residues and Physico-chemical characteristics of water samples of Hunsur taluk.

Seasons	1		2		3		4		5	
	Urea		DAP		pH		Conductivity		Total dissolved solids	
	B	C	B	C	B	C	B	C	B	C
R1 2011	1.231	2.134	3.68	3.94	7.373	7.438	0.77	0.41	403.5	216.06
R2 2012	1.048	1.702	4.105	3.888	7.451	7.357	0.77	0.45	424.6	236
R3 2013	1.249	1.26	4.205	4.02	7.453	7.514	0.773	0.494	427.8	250.6
W1 2011	1.19	1.686	4.223	4.194	7.422	7.500	0.709	0.452	396	235.2
W2 2012	1.19	1.686	4.894	5.168	7.436	7.514	0.766	0.48	393.1	235.2
W3 2013	1.12	1.344	4.751	3.86	7.393	7.54	0.792	0.532	409.4	243.4
S1 2011	0.331	0.522	2.329	2.218	7.295	7.316	0.733	0.434	376.5	188
S2 2012	0.55	0.66	2.148	1.828	7.241	7.302	0.724	0.448	375.9	268.2
S3 2013	0.81	0.76	1.842	1.632	7.354	7.368	0.685	0.4	468.2	277.6
WHO stds	-		-		7-8.5		0.250		500	

Seasons	6		7		8		9		10	
	Total Hardness		Calcium		Magnesium		Chloride		Dissolved oxygen	
	B	C	B	B	C	B	C	C	B	C
R1 2011	732.4	465.6	141.7	94.52	63.2	6.89	6.654	116.8	81.82	80.42
R2 2012	732.5	496.8	124.1	104.3	71.2	6.90	6.876	96	82.8	67.4
R3 2013	729.3	535.8	130.5	109	76.8	6.939	6.856	99.64	86.5	75.4
W1 2011	735.1	479.4	150.7	113.9	75.8	6.853	6.846	111.6	81.32	81.72
W2 2012	711.2	478.8	140.2	101	68.6	6.657	6.92	91	83.4	74.2
W3 2013	685.7	470.8	136.1	102.4	68.6	6.689	6.766	84.8	76	71.4
S1 2011	602	446.6	127.4	125.5	76.8	6.853	6.574	106.2	84.04	81.84
S2 2012	562.2	450	117.5	117	70.2	6.604	6.501	87.4	76.5	75.6
S3 2013	540.8	444.4	123.1	124	76.4	6.567	6.571	90.8	71.9	75.84
WHO stds	500		100		150		250-1000		6.0	

Seasons	11		12		13		14		15		16	
	Sodium		Potassium		Nitrate		Nitrite		Phosphate		Sulphate	
	B	C	B	C	B	C	B	C	B	C	B	C
R1 2011	111	135.8	20.8	31.8	61.4	68	0.03	0.024	2.65	2.84	37.8	62.4
R2 2012	101.6	121.4	24.4	40.2	71.2	69.6	0.037	0.03	3.01	2.8	61.2	54.2
R3 2013	93.9	108.6	25.8	31.4	80.4	69	0.037	0.03	3.14	2.92	66.5	54.6
W1 2011	122.7	127.4	22	39.8	75.8	71.8	0.03	0.024	2.99	3.16	45.7	76.8
W2 2012	115.7	127.4	23.6	40.4	79.5	89	0.037	0.03	3.48	3.48	49	88.6
W3 2013	114.5	110.2	22.4	40.6	84.4	78.4	0.037	0.03	3.42	2.78	55.1	89.2
S1 2011	87	131.6	30.4	41.2	80.8	84	0.03	0.024	1.68	1.7	45.2	73.8
S2 2012	88.7	113.8	34.2	41.6	71.3	84	0.037	0.03	1.55	1.32	48.8	78.4
S3 2013	88.6	116.6	37.3	45.8	73.2	85.2	0.037	0.03	1.33	1.18	50	79.8
	200		12		50		0.02		0.10		250	

NOTE: B-Bore well water, C-Channel water. All units are expressed in mg/L, except pH, conductivity (dS/m)

Result and Discussions:

Urea residues:

The present study shows, variation of pH in water samples. In bore well water samples, the concentrations ranged from 0.55 ppm (S2 2012) to 1.249 ppm (R3 2013). In channel water samples, the concentrations ranged from 0.522 ppm (S1 2011) to 2.134 ppm (R1 2011). Highest concentrations were recorded in channel water samples during rainy season. The concentration of urea residues in different water samples varied with respect to crops cultivated, soil types which influence on surface runoff.

Diammonium phosphate residues (DAP):

In bore well water samples, the concentrations ranged from 0.55 ppm (S2 2012) to 1.249 ppm (R3 2013). In channel water samples, the concentrations ranged from 0.522 ppm (S1 2011) to 2.134 ppm (R1 2011). Highest concentrations were recorded in channel water samples during rainy season. Unlike urea, the degradation capacity of DAP fertilizer in soil and water systems was very less compared to urea. During rainy season or in case of lands with good irrigation facilities, leaching and surface runoff of left out residues will be more.

PH:

In bore well water samples, the parameter ranged from 7.241 (S2 2012) to 7.453 (R3 2013). In channel water samples, the parameter ranged from 7.302 (S1 2011) to 7.514 (R1 2011). Highest parameters were recorded during rainy season in channel water samples. During 2011-2013, the variations in pH were found to be within the permissible limits of WHO standards. The results also show that, in some of the sampling locations, the alkaline pH was particularly due to presence of cations like Calcium, Magnesium and Sodium [2, 3, 6].

Electrical Conductivity (EC):

In bore well water samples the parameter ranged from 0.685 dS/m (S3 2013) to 0.792 dS/m (W3 2013). In channel water samples, the parameter ranged from 0.4 dS/m (S3 2013) to 0.532 dS/m (W3 2013). The mean parameter for electrical conductivity in all the water samples was found to be above the permissible limits of WHO standards. Highest parameter was recorded in winter season. Even though the variations in conductivity were observed, the mean parameter of conductivity in all the water samples was found to be above the permissible limits of WHO Standards.

Total Dissolved Solids (TDS):

In bore well water samples the concentrations ranged from 375.9 mg/L (S2 2012) to 468.2 mg/L (S3 2013). In channel water samples, the concentrations ranged from 188 mg/L (S1 2011) to 277.6 mg/L (S3 2013). The high TDS concentrations were reported in bore well water samples. The TDS concentrations up to 1000 mg/l were permissible for drinking and agricultural purposes. The present study concludes that, the water can be used for agricultural and drinking purposes.

Total Hardness (TH):

In bore well water samples the concentrations ranged from 540.8 mg/L (S3 2013) to 735.1 mg/L (W1 2011). In channel water samples, the concentrations ranged from 444.4 mg/L (S3 2013) to 535.8 mg/L (R3 2013). The mean concentrations of total hardness were found to be slightly above the desirable limits of WHO standards. The mean concentrations were higher for bore well water samples. The desirable limit for total hardness in water samples is 500 mg/L. Majority of the studies shows that, the climate and geology are the major factors in contributing the total hardness.

Calcium and Magnesium:

In bore well water samples, the concentrations ranged from 540.8 mg/L (S3 2013) to 735.1 mg/L (W1 2011). In channel water samples, the concentrations ranged from 444.4 mg/L (S3 2013) to 535.8 mg/L (R3 2013). In present study, in all the seasons shows calcium above the permissible limits in bore well water samples. Higher concentrations were reported during winter season. In case of magnesium, the mean concentrations were within the permissible limits of WHO standards. Although the sources of calcium in bore well water resources is mainly associated with calcium bearing rocks, the prolonged agricultural activities prevailing in the study area may also be directly or indirectly relating to the dissolution of minerals in water resources [7].

Chloride:

In bore well water samples, the concentrations ranged from 94.52 mg/L (R1 2011) to 125.5 mg/L (S1 2011). In channel water samples, the concentrations ranged from 63.2 mg/L (R1 2011) to 76.8 mg/L (R3 2013). The chloride concentrations in all the seasons were found to be within the permissible limits of WHO. Higher mean concentrations were recorded in bore well water samples. 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

Sodium and Potassium:

In bore well water samples, the concentrations ranged from 87 mg/L (S1 2011) to 122.7 mg/L (W1 2011). In channel water samples, the concentrations ranged from 108.6 mg/L (R3 2013) to 135.8 mg/L (R1 2011). The potassium concentration in bore well water samples, ranged from 20.8 mg/L (R1 2011) to 37.3 mg/L (S3 2013). In channel water samples, the concentrations ranged from 31.4 mg/L (R3 2013) to 45.8 mg/L (S3 2013). The mean concentrations of sodium were found to be above the desirable limits of WHO standards. In case of potassium, the concentrations were found to be higher in comparison with WHO standards.

Nitrate and Nitrite:

In bore well water samples, the concentrations ranged from 61.4 mg/L (R1 2011) to 84.4 mg/L (S3 2013). In channel water samples, the concentrations ranged from 68 mg/L (R1 2011) to 85.2 mg/L (S3 2013).

The concentration of Nitrite in bore well water samples, the concentrations ranged from 0.03 mg/L (R1 2011) to 0.037 mg/L (S3 2013). In channel water samples the concentrations ranged from 0.03 mg/L (W2 2012) to 0.024 mg/L (R1 2011). The observed mean concentrations for all the seasons were found to be above the desirable limits of WHO standards. In case of nitrite, a trace amount was detected in selected water samples because of continuous fertilizer application and irrigation runoff from the agricultural fields**.**

Phosphate and Sulphate:

In bore well water samples the concentrations ranged from 1.33 mg/L (S3 2013) to 3.48 mg/L (W2 2012). In channel water samples the concentrations ranged from 1.7 mg/L (S1 2011) to 3.48 mg/L (W2 2012). The sulphate concentration in bore well water sample ranged from 37.8 mg/L (R1 2011) to 3.48 mg/L (R3 2013). In channel water samples, the concentrations ranged from 54.2 mg/L (R2 2012) to 72.8 mg/L (S3 2013). The observed results in all the seasons showed, phosphate concentrations higher than the desirable limits. Higher concentration of Phosphate and Sulphate were recorded in bore well water samples for all the seasons. The higher concentration of phosphate may be due to the continuous application of Diammonium phosphate fertilizer to the agricultural soil. In case of Sulphate, in all the seasons, the mean concentrations were within the desirable limits of WHO standards.

Conclusion

The present investigation on seasonal analysis of chemical fertilizer residues along with physico-chemical characteristics can be concluded that, highest concentrations of chemical fertilizer residues were recorded in channel water samples during rainy season. The variations in pH were found to be within the permissible limits of WHO standards. The results also showed that, in some of the sampling locations, the alkaline pH was particularly due to presence of basic cations. In all the water samples, the conductivity and TDS parameters were found to be above the permissible limits of WHO Standards. In all the seasons calcium was above the permissible limits in bore well water samples. Higher concentrations were reported during winter season. In case of Magnesium and Chloride, the mean concentrations were within the permissible limits of WHO standards. The mean concentrations of Sodium were found to be above the desirable limits of WHO standards. In case of Potassium, the concentrations were found to be higher in comparison with WHO standards. In case of the Nitrate the mean concentrations were found to be above the desirable limits of WHO standards. A trace amount of Nitrite was detected in selected water samples. Higher concentrations of Phosphate and Sulphate were recorded in bore well water samples for all the seasons. The present study concludes that, compared to bore well water, channel water samples are more susceptible to fertilizer pollution.

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