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Assessment of urea residues in agricultural soil samples around Mysore, Karnataka, India

J. Divya*, S.L. Belagali

Department of Studies in Environmental Science, University of Mysore, Mysore-570 006, Karnataka, India

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The present study comprises the analysis of 12 soil samples from rainfed, irrigated and garden lands of agricultural areas around Mysore. The soil samples were analyzed for urea residues, texture, moisture content, bulk density, particle density, water holding capacity, pH, EC, chloride, organic carbon, calcium, magnesium, total nitrogen, ammoniacal nitrogen, nitrate, sodium, potassium and phosphorus. The study reveals that the application of urea fertilizer has a great influence on the physico - chemical properties of the soil. The soil samples S4 and S7 were found to be acidic in nature. Decline in the levels of basic cations like calcium and magnesium was reported compared to the normal levels in the majority of the sampling areas. Higher phosphorus levels were found in all sampling areas, which is due to over-use of phosphate fertilizers. From the study it was concluded that judicious application of urea fertilizers may help maintaining soil quality and productivity. However, it is necessary to apply a liming material to reduce the acidifying effect on agricultural lands in order to maintain basic cation levels in soil.

Key words: urea residues, soil properties, rainfed, irrigated, garden lands, judicious application

1. INTRODUCTION

Urea is one of the nitrogenous fertilizers which has received widespread attention in agriculture, because of its potential capacity of alleviating seedling damage, nitrate toxicity, ammonia volatilization, air and water pollution problems [1-2]. When urea is applied to soil, it is rapidly hydrolyzed to ammonia and carbon dioxide by soil urease enzyme. The rate at which urea gets hydrolyzed is closely related to soil physico-chemical characteristics such as soil pH, moisture content, organic carbon and temperature [3]. Generally inorganic fertilizers are applied to maintain or improve crop yield but their application causes directly or indirectly changes in the physical and chemical properties of the soil. Some of the studies have shown that continued use of inorganic fertilizers may result in lowering soil quality and productive capacity [4]. Studies of urea residues in soil extracts were reported by very few researchers [5,6]. Studies of the physico-chemical characteristics of agricultural soils were reported by several researchers [7-17]. However, not much work is reported on determination of urea residues along with the physico-chemical characteristics of agricultural soils. Therefore, the present study was undertaken to investigate the physico-chemical characteristics of soils along with urea residues, particularly in the agricultural lands around Mysore, with a view to understand the role of urea residues on soil quality.

2 MATERIALS AND METHODS

Study area: Agriculture is the predominant occupation in Mysore. The total geographical area of Mysore is 81740 hectares, out of which, 38600 hectares corresponds to cultivable lands. The study area, lying on 12^0 30' N latitude and 76^0 65' E longitudes, receives annual rainfalls of about 798 mm. During the past 15 years, the consumption rate of chemical fertilizers in Mysore has been about 83,353 metric tons per year, out of which 50% contribution was for nitrogenous fertilizers, particularly urea. The description of the sampling place, cropping pattern, fertilizer type and quantity applied is presented in Table 1.

Collection of the soil samples: The sampling area was divided into rainfed, irrigated and garden lands. From each of the farm lands, four composite soil samples were collected. The soil samples were collected at a 0-15 cm depth. The soil samples were air-dried, ground, sieved through a 2 mm sieve and stored in polythene bags until analysis.

Analysis of soil: The soil samples were analyzed for texture, moisture content, bulk density, particle density, pH, electrical conductivity, organic

* To whom all correspondence should be sent:
e-mail: divyajenv@gmail.com

carbon, total nitrogen, phosphorus, sodium, potassium, calcium, magnesium, ammoniacal nitrogen, nitrate and urea residues.

Experimental work: The textural analysis was carried out by the international pipette method and the soil moisture content was assessed by a gravimetric method. The bulk density and particle density were determined using the Core sampler method and the volumetric flask method. The urea residues were quantified spectrophotometrically by the reaction of urea with diacetylmonoxime under acidic conditions. The soil pH was measured in 1:5 soil/water suspensions using a pH meter with a glass electrode. The electrical conductivity of the soil extracts was determined using a conductivity meter. The organic carbon was determined by the potassium dichromate wet oxidation method. The total nitrogen was determined by the Kjeldahl distillation method, while the available phosphorus was determined by Trough's method. Sodium and potassium were determined by flame photometry. Calcium and magnesium were determined by EDTA titration and the ammoniacal nitrogen - by Nessler's reagent method.

3. RESULTS AND DISCUSSION

The results for the physico-chemical characteristics and the content of urea residues in the soil samples are presented in Table 2.

The ordinary examination of the soil in the studied area reveals that the soil samples are of sandy, clay, clay-loam, and sandy-clay texture. The water holding capacity is the amount of water retained in the soil pores. Generally, in medium-textured soils, the amount of water retained is very low when compared to clay-textured soil. In the present study the water holding capacity ranged from 46.8 to 90.3 %. Except for the samples S4 and S12, all soil samples were found to have a high water holding capacity, which is due to the large pore space present in-between the soil particles, helping to retain a larger amount of water.

Bulk density is defined as the mass of soil material per unit volume of moist soil in natural undisturbed conditions. The bulk density of clay and clay-loam soils normally ranges from 1 to 1.65 mg/m^3. Variation of the bulk density from 1.20 to 1.80 mg/m^3 could be found in sandy and sandy-loam soils. In the present studied area, the bulk density ranges from 0.94 to1.3 mg/m^3. In some of the soil samples lower bulk densities were reported, which may due to the high organic carbon content in the soil.

The particle density is the density of solid particles in the soil sample. In the studied area, 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 quartz minerals in the soil matrix. High particle density indicates the presence of iron-rich soils, e.g., the density of ferromagnesian minerals ranges from 2.9 to 3.5 mg/m^3 and the density of iron oxides and other heavy minerals can reach up to 5 mg/m^3.

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. The pore space of a soil varies depending on soil texture, shape of individual soil particles, organic carbon content, and nature of crop soil management. In the present study, the porosity values ranged from 45 to 77.6 %. Lower porosity is reported for S12 and higher one - for S1. The soils are of sandy and clay texture. Generally, the pore space in sandy soils is very low when compared to clay soils, while the compactness between soil particles is higher in clay soils rather than in sandy soils.

The urea residues are found to range from 1.12 to 8.73 kg/ha. Generally, when urea is applied to the soil, it is rapidly hydrolyzed to ammonia and carbon dioxide by the urease enzyme present in the soil. The rate of degradation depends on soil pH, temperature, moisture content, organic carbon and quantity of urea applied. In the present study, high urea residues were reported in S7, which is due to the acidic nature of this sampling area. Acidic conditions reduce the urease enzymatic activity in the soil.

The present study on, irrigated and garden lands shows a pH range from 5.81 to 8.31. Soils with pH values from 5.5 to 6.5 are lime free and are satisfactory for most of the crops. pH values from 6.5 to 7.5 are most favorable for the crops and plants.

Electrical conductivity values from zero to 2 dS/m are safe for all crops. The EC values of the studied area varied from 0.11 to 1.04 dS/m, which reveals that most of the soil samples have a safe range of electrical conductivity.

Organic carbon is an index of soil productivity and reflects the amount of carbon broken down from plants and animals, which is stored in the soil. In the present study the organic carbon content in the soil samples of the studied area ranged from 0.57 to 7.23 %. The organic carbon in all soil samples was found to be high, which may due to decomposition of crop residues on the soil surface.

The ammonia and nitrate concentrations in the soil samples of the studied area were 3.13 – 12.54 kg/ha and 2.68-18.86 kg/ha, respectively. These values mainly depend on the moisture content and the enzymatic activity in the soil (which may vary from one place to another).

The total nitrogen content values for all soil samples were found to be in the range from 784 to 1784.8 kg/ha. The high nitrogen values are due to both the excessive application of nitrogenous fertilizers and the leguminous crop rotation.

The calcium and magnesium ions were found to range from 1.8 to 12.7 meq/l and from 1.0 to 11.4 meq/l, respectively, except for the sample S3. Sodium and potassium concentrations were found to be between 100.8 to 257.6 kg/ha and 44.8 to 188.16 kg/ha, respectively. For urea-applied soils, the hydrolysis of urea yields nitrate ions which are not strongly adsorbed by the soil particles and will move down through the soil profile. The negatively charged nitrate ions carry positively charged basic cations, such as calcium, magnesium, sodium, and potassium in order to compensate for the electrical charge on the soil particles. The depletion of these basic cations will accelerate the acidification process of the soil which is another reason for the decrease in soil pH.

Phosphorus levels in the studied area varied from 62.72 to 288.96 kg/ha. The available phosphorus levels in all sampling areas were found to be higher than the normal range, which is due to excessive application of phosphate fertilizers [18].

These results are demonstrated in Figs. 1-3.

Table 1. Sampling points with sampling codes, crop types and types of fertilizers applied to the agricultural field

No	Sampling location	Types of crops cultivated	Types of fertilizer	Land type	Quantity of urea applied, kg/ha
S1	Marballi	Ragi, Vegetables	Urea	Rainfed area	100
S2	Arasinakere	Cotton	Urea	Rainfed area	100
S3	Jayapura	Maize, Cabbage, Cauliflower, Tomato	Urea	Rainfed area	100
S4	Doora	Banana, Papaya, Pomegranate, Lemon	Urea	Rainfed area	100
S5	Varakodu	Areca nut, Banana plantation	Urea	Irrigated land	100
S6	Mosaimbayanahalli	Ragi, Paddy, Maize	Urea	Irrigated land	100
S7	Duddgere	Ragi, Paddy	Urea,	Irrigated land	100
S8	Varuna	Paddy	Urea	Irrigated land	100
S9	Koppalure	Coconut, Areca nut	Urea	Garden land	100
S10	Gejjagalli	Sugar cane, Green leafy vegetables	Urea	Garden land	100
S11	Mandakalli	Turmeric, Banana plantation, Green leafy vegetables	Urea	Garden land	100
S12	Bandipalya	Coconut, Green leafy vegetables, Banana	Urea	Garden land	100

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Table 2. Physico-chemical characteristics of agricultural soil samples of Mysore.

Parameters	Normal range	Rainfed area				Irrigated land				Garden land			
		S-1	**S-2**	**S-3**	**S-4**	**S-5**	**S-6**	**S-7**	**S-8**	**S-9**	**S-10**	**S-11**	**S-12**
Texture	-	Clay	Sandy loam	Sandy Clay loam	Sandy	Clay sand	Sandy clay loam	Sandy clay loam	Sandy clay loam	Sandy clay loam	Sandy loam	Sandy loam	Sandy soil
Moisture content %	-	37.5	32.5	43.33	10.2	13.04	13.63	18.18	19.04	22.5	37.03	20	14.13
WHC %	-	90.3	78.3	87.6	47.9	69.8	66.92	52.8	71.8	73.8	54.6	52.9	46.8
Bulk density mg/m^3	1-1.65	1.12	1.2	1.12	1.3	0.98	1.18	0.98	1.06	0.94	1.1	1.16	1.1
Particle density mg/m^3	2-2.65	5	2.5	3.33	2.5	2.5	3.33	2.5	3.33	3.33	2.5	2.5	2
Porosity %	30-55	77.6	52	66.4	48	63.2	64.6	60.8	68.2	71.5	56	53.6	45
UREA Residues 100 kg/ha	-	**1.12**	**-**	**2.68**	**7.16**	**6.27**	**4.48**	**8.73**	**3.80**	**2.68**	**1.56**	**2.01**	**3..58**
pH	6.5-7.5	7.81	6.94	8.16	6.51	8.12	7.02	5.81	7.94	7.78	7.39	8.31	8.09
Conductivity ds/m	0-2	0.31	0.36	0.39	0.11	0.23	0.18	1.04	0.62	0.41	0.48	0.29	0.48
Calcium meq/lit	10-30	8.7	1.9	12.7	8.2	3.9	2.6	3.9	1.8	7.4	9.1	4.6	5.6
Magnesium meq/lit	5-10	3.2	1.8	11.4	6.4	2.9	3.9	4.1	1.0	3.4	7.1	5.2	4.1
OC %	0.50-0.75	0.57	1.32	1.98	0.69	2.29	2.61	1.89	2.7	7.23	1.23	0.62	1.8
Chloride %	0.020-0.120	0.0923	1.597	0.0639	0.0852	0.0639	0.0142	0.113	0.0497	0.0994	0.149	0.0568	0.0284
TN Kg/ha	200-500	1254.4	784	1254.4	1724.8	705.6	1077.6	940.8	627.2	1411.2	1176	1960	1411.2
Ammonia kg/ha	-	7.39	5.82	9.40	4.25	6.72	7.84	3.36	4.92	12.54	5.82	7.39	3.13
Nitrate kg/ha	-	6.72	5.37	7.61	5.6	7.16	4.48	3.13	2.68	8.08	3.58	4.92	18.86
Sodium kg/ha	-	219.52	257.6	208.32	244.18	129.92	100.8	194.88	159.04	150.08	217.28	132.16	145.6
Potassium kg/ha	50-125	168	188.16	165.76	170.24	53.76	58.24	76.16	44.8	76.16	96.32	51.52	64.96
Phosphorus kg/ha	11.2-22.4	194.88	134.4	134.4	235.2	170.24	132.16	288.96	62.72	125.44	105.28	125.44	210.56

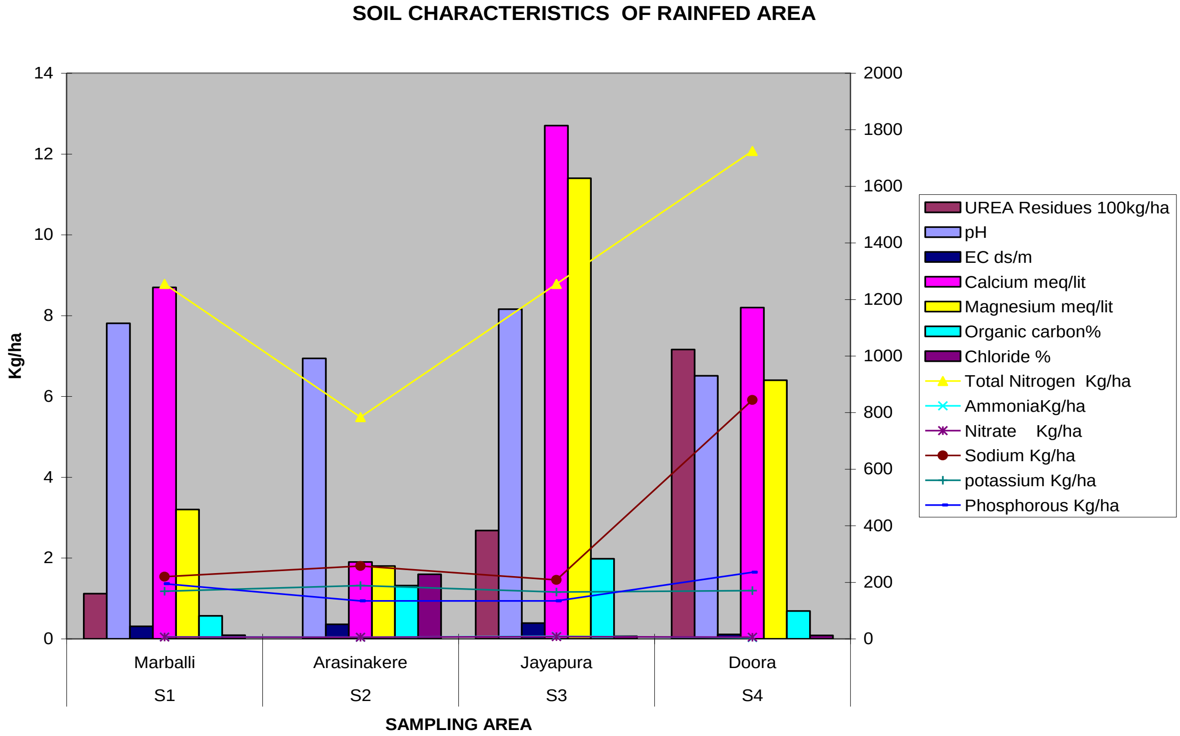

Fig.1. Soil characteristics of rainfed area.

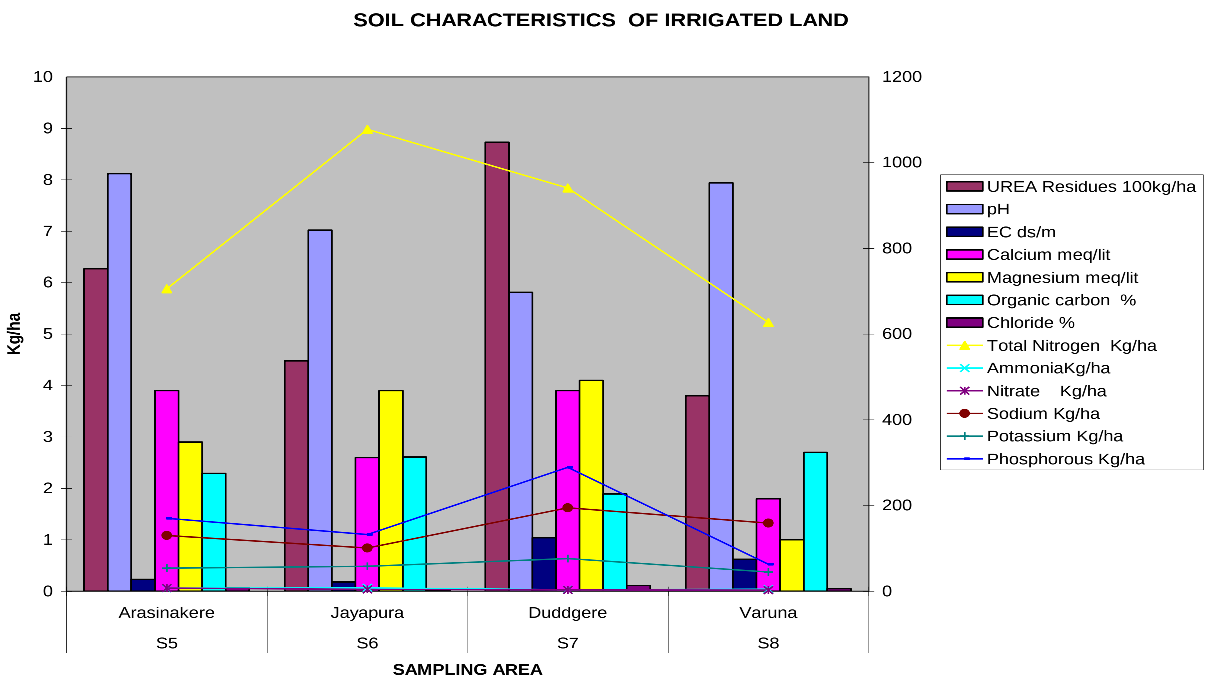

Fig.2. Soil characteristics of irrigated land.

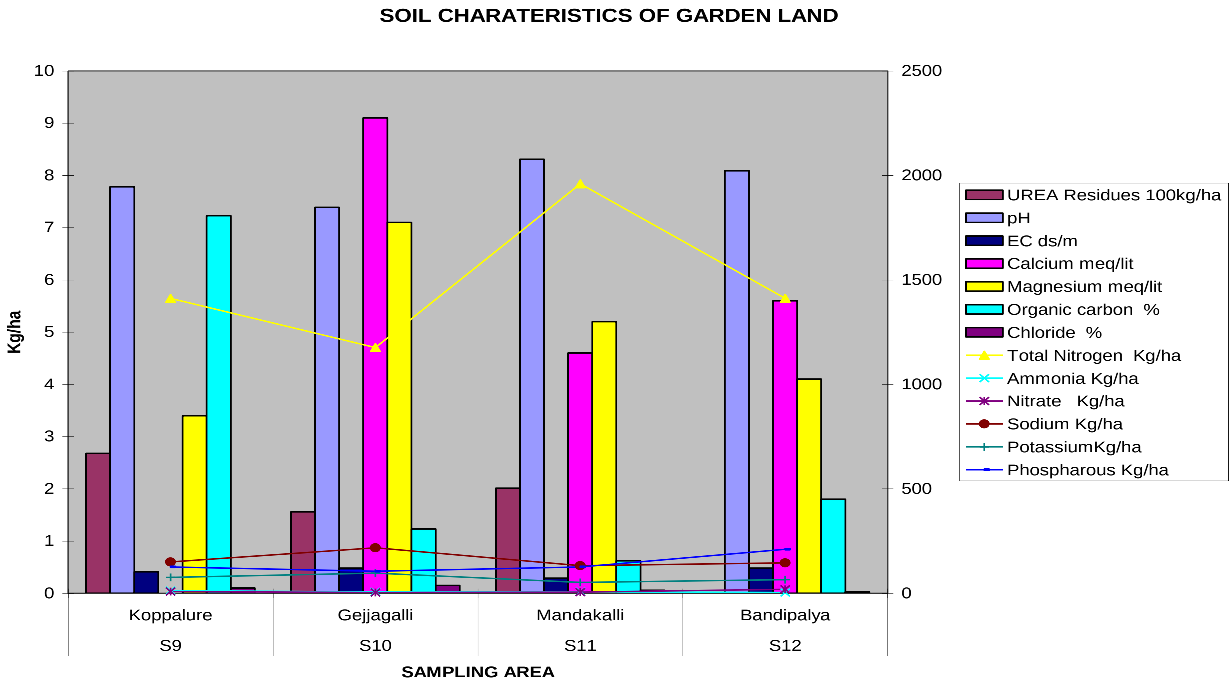

Fig.3. Soil characteristics of garden land.

4. CONCLUSIONS

The present study indicates that the application of urea fertilizers has a great influence on the physico-chemical properties of the soil. The pH values of soil samples S4 and S7 were found to be acidic and declining in basic cations. In all sampling areas the phosphorus levels were found to be higher, which is due to over-use of phosphate fertilizers. It follows from the study that judicious application of inorganic fertilizers must be kept in order to preserve soil quality and productivity. It is necessary to apply liming material to reduce the acidification of agricultural lands and to maintain basic cation levels in soil.

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ОПРЕДЕЛЯНЕ НА ОСТАТЪЧЕН КАРБАМИД В ПРОБИ ОТ ЗЕМЕДЕЛСКИ ПОЧВИ ОКОЛО ГР. МАЙСОР, ЩАТ КАРНАТАКА В ИНДИЯ

Дж. Дивя, С.Л. Белагали

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(Резюме)

Настоящето изследване съдържа анализи на 12 почвени проби от естествено напоявани, напоявани и градински земи в земеделската област около гр. Майсор. Пробите са анализирани за остатъчен карбамид, влага, текстура, обемна плътност, плътност на частиците, влагозадържащ капацитет, pH, електропроводимост, хлориди, органичен въглерод, калций, магнезий, общ азот, амонячен азот, нитрати, натрий, калий и фосфор. Изследването разкрива, че употребата на карбамида като тор има голямо влияние върху физико-химичните свойства на почвите. Установено е,ч е почвени проби S4 и S7 са естествено кисели. Намерени са отклонения от нивата на основни катиони, като калций и магнезий за мнозинството на пробовзиманията. Установени са повишени нива на фосфора за всички изследвани места, което се дължи на прекомерно торене с форфорни торове. Направено е заключението, че разумната употреба на карбамид може да спомогне за поддържането на качеството на почвите и плодородието им. Необходимо е обаче да се следи за киселинния ефект върху земеделските земи, за да се поддържа основното основното ниво на катионите в тях.