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Quality of commonly used fertilizers collected from different areas of Bangladesh

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Abstract

Total 54 fertilizer samples were randomly collected from the markets of four districts of Bangladesh to assess nutrient and heavy metal (Cd, Cr & Pb) contents in different fertilizers. The chemical analyses of fertilizers were conducted at the Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh. Nutrient status of fertilizers was determined using the standard procedures and heavy metals in the fertilizer extract were analyzed using Atomic Absorption Spectrophotometer (AAS). Nitrogen (N) content in urea collected from different areas ranged from 41.37 to 46.27%. Biuret content of the collected urea samples varied from 1.40 to 2.80%, where the maximum allowable limit (MAL) is 1.50%. Among the six urea samples, biuret content exceeded the MAL in five samples. Phosphorous (P) content in most of the triple superphosphate (TSP) samples was higher than the specified amount. Out of eight samples, only two samples contained less than 20% P. Out of eight diammonium phosphate (DAP) samples, only three samples contained lower amount of P than the specified amount and five samples contained lower amount of N than the specified amount. Chromium content in all the DAP samples were much higher than the MAL. Potassium (K) content in all five collected muriate of potash (MoP) samples were lower than the specified amount with an average of 45.81% K. The concentration of sulphur (S) in fertilizer samples in the investigated area varied from 16.50 to 21.60%. Out of six magnesium sulphate samples, five samples contained lower than the specified amount (9.5%) of Mg. The concentration of boron (B) in solubor samples varied from 13.55 to 19.56%, which are lower than the standard limit (20.90%). The concentration of zinc (Zn) in all the collected zinc sulphate heptahydrate samples had lower amount of Zn than the standard limit (23%). Only one out of six collected copper sulphate samples, met the specified limit of Cu (25.40%). Total 42 fertilizer samples (77.80%), out of 54, had less than the specified amount of nutrients. Heavy metals like Pb and Cr content exceeded the MAL in 67% and 47% of collected fertilizer samples, respectively. Cadmium content was below the detectable limit of flame in AAS in all the samples. In order to minimize the impact of fertilizer adulteration on food security and safety, continuous monitoring of fertilizer quality is required.

Introduction

Fertilizer is the most critical and costly input for sustaining agricultural production and ensuring food security. Supplying crops with essential macro (and trace) elements is the major aim of any type of fertilizer. However, fertilizers may also contain less beneficial elements, particularly heavy metals (Kratz *et al.*, 2016). Adulteration in fertilizers is one of the emerging problems for intensive agriculture in Bangladesh. Adulteration of fertilizers involves the practice of adding extraneous material to a standard fertilizer to lower its quality. According to routine tests carried out by Soil Resource Development Institute (SRDI), nearly 40% of all fertilizers used by farmers are adulterated (FRG, 2012). During the last couple of decades agricultural production system in Bangladesh has been intensified. The soil has been over exploited to produce more food from the limited areas of land for the growing population. During the past few years, total fertilizer use in Bangladesh has increased significantly. The quality of fertilizers being sold to the farmers is often exploited by the unscrupulous elements. Recently reports regarding fertilizer adulteration are very common in print and electronic media. Depending on the source, harmful heavy metals like cadmium (Cd), arsenic (As), chromium (Cr), lead (Pb), mercury (Hg), and radionuclides like uranium (U), radium (Ra), and thorium (Th) may be introduced into the soil along with the fertilizer, which are then absorbed by growing crop plants causing significant health related issues (Mortvedt and Beaton, 1995). It is estimated that 54–58% of the Cd found in the environment comes from the application of mineral phosphate fertilizers (Tirado and Allsop, 2012). The Government of Bangladesh has promulgated a regulation entitled “Fertilizer (Management) Regulation, 2007” through which regulatory frameworks for commercial production, procurement, import, distribution, storage and marketing of organic and inorganic fertilizers and fertilizer materials incorporated. The content of unwanted elements in fertilizers is regulated in Bangladesh by this regulation which defines limit values for Cd, Cr and Pb. However, unscrupulous producers used to produce and sell adulterated fertilizer materials either through poor blending quality or mixing or dilution (e.g. mixing poor fertilizer or fertilizer like materials with good one) and/or rebagging through

putting poor quality or cheap fertilizer in bag labeled with the good one, coating with industrial dye to change product appearance. For this reason a new section has been introduced in Fertilizer Recommendation Guide, 2012; entitled "Identification of Adulterated Fertilizers'. According to the experts, one among the major reasons of pollution in the agricultural field is the use of adulterated fertilizers that are bought from the small holders or from the unauthorized companies. Fertilizer companies sell their products without any chemical analysis. Farmers collect those fertilizers from the local market, which are too much adulterated by brick particles, gravels, rock particles etc. Fertilizers reach to the local market from its manufacturing industries by passing many dirty situations. Moreover, by applying such contaminated fertilizers, farmers are cheated and production suffers leading to economic deprivation of farming community. The Government of Bangladesh used to give huge subsidy in fertilizer production and marketing. Using adulterated or misbranding fertilizers leads to national loss in terms of production and economy. Considering the above facts, the present research study was planned to identify nutritional composition of different fertilizers collected from different areas of Bangladesh and to determine the levels of nutrient and heavy metals (Cr, Cd & Pb) in fertilizers and compare the content of heavy metals with the standards for maximum allowable limits.

Materials and Methods

Sampling sites

Fertilizer samples were collected from local markets of 4 districts of Bangladesh: Mymensingh, Chittagong, Rajshahi and Bogra. Fertilizers sampling were performed during January to February, 2016.

Collection of fertilizer samples

Total 54 fertilizer samples were collected from the local market of selected districts. Fertilizers were: 6 urea samples, 8 triple superphosphate samples, 8 diammonium phosphate samples, 5 muriate of potash samples, 6 magnesium sulphate samples, 4 gypsum samples, 6 zinc sulphate heptahydrate samples, 5 solubor samples and 6 copper sulphate samples.

Preparation of composite sample

A small portion of the material from different parts of each container was drawn with an appropriate sampling instrument. Then, the collected sample was mixed thoroughly to obtain a composite sample. The composite sample size was reduced by the method of quartering if the composite sample was much larger than about 2 kg in weight.

Preparation of test sample

The composite samples were spread out on a clean and hard surface. The samples were divided into three more or less equal portions, not less than 0.5 kg each to obtain the test sample. Then, each test sample was immediately transferred to a suitable container provided with an air tight stopper.

Preparation of sample for analysis

The gross sample was reduced to quantity sufficient enough for analysis or grinding, not less than 0.25 kg of reduced sample without previous sieving. The reduced sample was ground in porcelain mortar with pestle in order to pass through a sieve with 1 mm circular opening or 20 mesh sieve for moist fertilizer or 40 mesh sieve for dry fertilizer. It was mixed thoroughly and stored in an air tight bottle (Cattalo and Robinson, 2001).

Preparation of extracts

Exactly 1g of the ground prepared fertilizer samples were weighed and taken in 100 mL volumetric flask. Approximately 800 mL of water was added to the flask and shaked thoroughly to dissolve the fertilizer. Then the solution was filtered through filter paper (Whatman No. 1) twice and finally the volume was made up to 100 mL and stored in a plastic container (Lindsay *et al*., 2003).

Analysis of nutrient and heavy metal contents

Nutrient contents (N, P, K, Mg, S, B, Cu & Zn) of different fertilizer samples were determined by standard methods of analysis (Page *et al.,* 1982; Tandon, 2013). Biuret content in urea fertilizers were determined spectrophotometrically (Geurts *et al.*, 1968). Heavy metals (Cd, Cr & Pb) in fertilizer samples were analyzed using an atomic absorption spectrophotometer (AAS) (SHIMADZU, AA-7000; Japan). Mono element hollow cathode lamp was employed for the determination of each heavy metal of interest. At first, AAS was calibrated following the manufacturer's recommendation. The filtered fertilizer sample was run directly for the determination of heavy metal in fertilizer samples. A standard curve was prepared by plotting the absorbance reading on Y-axis versus the concentration of each standard solution of metal on X-axis. Then, the concentration of metal in the fertilizer samples of interest was calculated by plotting the AAS reading on the standard line.

Statistical analysis

The statistical analysis of the analytical results obtained from fertilizer samples under consideration was performed (Gomez and Gomez, 1984).

Results and Discussion

Urea fertilizer

Urea is the leading source of N containing fertilizer and the potential adverse effects of biuret present in urea on plant growth are a concern. Biuret applied to soil or plant foliage in high concentrations interferes with N metabolism and hinders protein synthesis in plants (Mikkelsen, 1990). The content of N in 6 urea fertilizers collected from different areas of Bangladesh ranged from 41.37 to 46.27% with the mean value of 44.73% and standard deviation of 1.78 (Table 1). The minimum value was 41.44% in the samples collected from

Mymensingh and the maximum value was 46.27% from Chittagong. The standard level of nitrogen in urea fertilizer is 46% (FRG, 2012). Urea which was collected from Chittagong (U_2) contained 46.27% N, which was better in content. But urea which was collected from Mymensingh (U_1) contained 41.37% N, which was less than the acceptable limit. Biuret is a chemical compound formed by the combination of two molecules of urea with a release of a molecule of ammonia when the temperature during the urea manufacturing process exceeds the controlled level. Proper use of N fertilizer and improving its recovery efficiency is the key to increase the yield of crops (Neeteson, 1995). From the biuret determination of urea fertilizer, the highest biuret (2.8%) was found in the sample collected from Ghorashal fertilizer factory (U_4) and it was higher than the maximum allowable level (MAL) (<1.5%) and the lowest biuret value was 1.4% from the sample collected from BCIC, Chittagong (U_5) (Table 1).

Table 1. Nutrient content in urea collected from different areas of Bangladesh

Sample No.	Sampling location	N %	Biuret %
U_1	Mymensingh	41.37	2.4
U_2	Chittagong	46.27	1.8
U_3	Bogra	46.13	1.6
U_4	Rajshahi	44.45	2.8
U_5	Rajshahi	45.01	1.4
U_6	Rajshahi	45.15	1.8
Mean		44.73	1.97
SD		1.78	0.52
CV (%)		3.98	.40
Specification*		46.00	1.5

Ref.:*FRG, 2012

Triple superphosphate fertilizer

Phosphate rock (PR) is the major source for the production of most of the world's phosphate fertilizers. International Fertilizer Development Center (IFDC) approximately predicted that world phosphate rock resources is 2,90,000 mmt with 60,000 mmt of concentrate (Kauwenbergh, 2010). The content of P in TSP fertilizer collected from different areas of Bangladesh ranged from 18.77 to 25.36% (Table 2). Out of the total 8 samples, 2 samples, collected from Mymensingh and Rajshahi contained 18.77 and 19.34 µg g^{-1} P, respectively. This level was below the standard level (20 µg g^{-1}) and the remaining 6 samples had standard amount of P. From AAS test, it was found that TSP samples had Pb concentration (71.4–168.5 µg g^{-1}) but in only 3 samples, Pb content was below the maximum allowable limit (100 µg g^{-1}).

The concentration of Cd in all the TSP samples was below the detection limit. TSP samples contained Cr ranging from 260.00–302.00 µg g^{-1}, which was below the MAL (500 µg g^{-1}). Demand of phosphorus application in agricultural production is increasing fast throughout the globe (Bolan *et al*., 2003). Phosphate rock contained 11, 25, 188, 32, 10, and 239 µg $g^{-1}$of As, Cd, Cr, Cu, Pb and Zn, respectively (Mortvedt and Beaton, 1995).

Diammonium phosphate fertilizer

The content of P in DAP collected from different areas of Bangladesh ranged from 18.67 to 24.04% with the mean value of 20.78% and standard deviation of 1.84 (Table 3). Among the 8 fertilizer samples, 3 samples from Mymensingh had P percentage having 19.81, 18.81 and 18.67 µg g^{-1}, respectively which were below the standard level (20 µg g^{-1}). According to Ayers and Westcot (1985), fertilizer generally contained 20% P is suitable for crops and soils. Among the 8 samples, 5 samples which were collected from Mymensingh, Chittagong Bogra and Rajshahi contained N with 17.85, 17.20, 17.20and 17.10 µg g^{-1}, respectively and those were lower than the standard limit (Table 3). The concentration of Pb in 5 DAP samples was higher than the MAL (Table 3). Rock phosphates are the main source of heavy metals and trace elements in mineral fertilizers, particularly those of sedimentary in origin, which make up at least 85% of the raw material used for mineral P fertilizer production (Kratz *et al*., 2011).

Muriate of potash fertilizer

Muriate of potash with up to 60% of K_2O is the leading straight potassium (K) fertilizer used on most crops. The concentration of K in the fertilizer samples in the investigated area varied from 44.53 to 47.11% (Table 4). Out of 5 MoP samples, all samples had K concentration less than the standard limit (50 µg g^{-1}). Potassium improved the water regime of the plant and increases its tolerance to drought, frost and salinity (Schmidt, 2003). In case of heavy metal concentration, all the collected samples contained higher amount of Pb (148.6–188.6 µg g^{-1}), which were higher than the MAL (100 µg g^{-1}). Trace amount of Cd was recorded in all the collected samples as the MAL is 10 µg g^{-1}. Chromium contents of the collected fertilizer samples from Mymensingh, Chittagong, Bogra and Rajshahi were 302, 310, 310 and 306 µg g^{-1}, respectively which were lower than the MAL (500 µg g^{-1}).

Table 2. Nutrient and heavy metal contents in triple superphosphate (TSP) collected from different areas of Bangladesh

Sample No.	Sampling location	P	Pb	Cd	Cr	Zn	Cu
		%			μg g^{-1}		
T_{1a}	Mymensingh	25.36	71.4	BDL	296	726.8	106.7
T_{1b}	Mymensingh	18.77	87.1	BDL	296	2.8	106.7
T_2	Bogra	20.20	95.7	BDL	302	720.8	110.3
T_{3a}	Chittagong	21.78	107.1	BDL	260	4.5	106.1
T_{3b}	Chittagong	22.06	168.5	BDL	266	721.3	107.2
T_{4a}	Rajshahi	21.63	127.1	BDL	280	58.5	108.4
T_{4b}	Rajshahi	22.21	138.6	BDL	278	9.7	104.4
T_{4c}	Rajshahi	19.34	148.6	BDL	262	34.7	109.0
Mean		21.42	118.0	BDL	280	284.9	107.4
SD		2.10	33.2	-	16.6	363.2	1.8
CV (%)		9.80	28.1	-	5.9	127.5	1.7
Specification*/MAL**		20	100	10	500	*NA	*NA

BDL= Below Detectable Limit of Flame in AAS
MAL=Maximum Allowable Limit, *NA=Not Applicable
Ref.: *FRG, 2012; **Fertilizer (Management) Regulation, 2007

Table 3. Nutrient and heavy metal contents in diammonium phosphate (DAP) collected from different areas of Bangladesh

Sample No.	Sampling location	P	N	Pb	Cd	Cr	Zn	Cu
		%				μg g^{-1}		
D_{1a}	Mymensingh	19.91	17.85	21.43	BDL	1290	145.8	521.3
D_{1b}	Mymensingh	18.81	17.94	42.86	BDL	1230	99.7	519.7
D_{1c}	Mymensingh	18.67	19.81	92.86	BDL	1300	BDL	522.1
D_{1d}	Mymensingh	24.04	19.25	150.0	BDL	1340	2.7	526.2
D_2	Chittagong	21.32	17.20	242.9	BDL	1330	BDL	536.1
D_3	Bogra	20.46	17.20	257.2	BDL	1390	BDL	530.3
D_{4a}	Rajshahi	21.08	17.10	300.0	BDL	1250	BDL	532.8
D_{4b}	Rajshahi	21.97	18.97	371.4	BDL	1210	3625.0	533.6
Mean		20.78	18.17	184.8	BDL	1293	968.3	527.8
SD		1.76	1.05	127.2	-	60.6	1772.1	6.3
CV (%)		8.47	5.78	68.83	-	4.7	183.0	1.2
Specification*/MAL**		20	18	100	10	500	*NA	*NA

BDL= Below Detectable Limit of Flame in AAS
MAL=Maximum Allowable Limit, *NA=Not Applicable
Ref.: *FRG, 2012; **Fertilizer (Management) Regulation, 2007

Gypsum fertilizer

Sulphur concentration present in the fertilizer samples in the investigated area varied from 16.50 to 21.6% (Table 5). Out of 4 gypsum samples, 2 samples collected from Bogra and Rajshahi, contained 16.50and 17.43 μg g^{-1}S, which are less than the standard value (18 μg g^{-1}). Considering this value as standard, 2 samples those were collected from Mymensingh and Chittagong had reasonable amount of S (21.60 and 18.03 μg g^{-1}, respectively). Thus, it is as important in plant growth as P and Mg; but its role is often under estimated (Wilberforce and Nwabue, 2012). Lead content in all the gypsum fertilizer samples were 3 to 4 times higher than the MAL (100 μg g^{-1}). However, Cr content in 2 gypsum fertilizer samples was lower than the MAL but exceeded in other 2 fertilizer samples. Cadmium content in all the samples was below the detectable limit.

Table 4. Nutrient and heavy metal contents in muriate of potash (MoP) collected from different areas of Bangladesh

Sample No.	Sampling location	K	Pb	Cd	Cr
		%		μg g^{-1}	
M_{1a}	Mymensingh	46.75	148.6	BDL	302
M_{1b}	Mymensingh	44.83	161.4	BDL	296
M_2	Chittagong	45.85	171.4	BDL	310
M_3	Bogra	44.53	178.6	BDL	310
M_4	Rajshahi	47.11	188.6	BDL	306
Mean		45.81	169.7	-	304.8
SD		1.13	15.5	-	5.9
CV (%)		2.47	9.1	-	1.9
Specification*/MAL**		50	100	10	500

BDL= Below Detectable Limit of Flame AAS, MAL=Maximum Allowable Limit
Ref.: *FRG, 2012; **Fertilizer (Management) Regulation, 2007

Magnesium sulphate fertilizer

Magnesium is the central constituent of chlorophyll, the green pigment of the leaves, which functions as an acceptor of the energy supplied with the help of the light energy of the sunlight energy, is transformed into chemical energy (Voudouris and Wagner, 2004). The concentration of Mg in magnesium sulphate fertilizer samples collected from different areas of Bangladesh was detected within the range of 8.77 to 9.63% (Table 6). Among the 6 samples from different locations, 2 samples from Rajshahi contained 8.7 7and 8.62% Mg, which are lower than the standard (9.5%). Magnesium is also involved in enzyme reactions related to the energy transfer of the plant (Portsch, 1991). The concentration of S in 3 collected samples had lower amount than the standard limit (12.5%) and other 3 samples had higher amount of nutrient. Lead content in all the magnesium sulphate fertilizer samples were 2 to 3 times higher than the MAL (100 μg g^{-1}). One samples collected from Rajshahi contained as high as 2276 μg g^{-1} Cr. Cadmium content in all the samples was below the detectable limit.

Table 5. Nutrient and heavy metal contents in gypsum collected from different areas of Bangladesh

Sample No.	Sampling location	S	Pb	Cd	Cr
		%		μg g^{-1}	
G_{1a}	Mymensingh	21.60	350.0	BDL	266
G_{1b}	Chittagong	18.03	367.1	BDL	684
G_2	Bogra	16.50	372.9	BDL	1040
G_3	Rajshahi	17.43	375.7	BDL	260
Mean		18.39	366.4	-	562.5
SD		2.23	11.5	-	375.1
CV (%)		12.13	3.1	-	66.7
Specification*/MAL**		18	100	10	500

BDL= Below Detectable Limit of Flame in AAS
MAL=Maximum Allowable Limit
Ref.: *FRG, 2012; **Fertilizer (Management) Regulation, 2007

Solubor fertilizer

Boron concentration present in the fertilizer samples of investigated areas varied from 13.55 to 19.56% (Table 7). The content of B in all the collected samples had lower amount of nutrient than the standard limit (20.9%). Solubor fertilizers collected from Rajshahi area showed minimum level of B. If excessive boron is applied, it may have a harmful effect on the crop and/or the succeeding crop (Zakir *et al.*, 2014). Lead content in all the solubor fertilizer samples exceeded the MAL (100 μg g^{-1}). However, chromium content in the solubor fertilizer samples was lower than the MAL. Cadmium content in all the samples was below the detectable limit.

Table 6. Nutrient and heavy metal contents in magnesium sulphate collected from different areas of Bangladesh

Sample No.	Sampling location	Mg	S	Pb	Cd	Cr
		%		μg g^{-1}		
Mg_1	Mymensingh	9.63	12.2	247.1	BDL	316
Mg_2	Bogra	9.23	11.5	254.3	BDL	304
Mg_{3a}	Rajshahi	9.10	12.9	262.9	BDL	676
Mg_{3b}	Rajshahi	8.77	13.2	281.4	BDL	686
Mg_{3c}	Rajshahi	9.20	12.6	291.4	BDL	2276
Mg_{3d}	Rajshahi	8.62	10.0	304.3	BDL	238
Mean		9.09	12.1	273.6	-	749
SD		0.36	1.2	22.4	-	773
CV (%)		3.96	9.9	8.2	-	103
Specification*/MAL**		9.50	12.5	100	10	500

BDL= Below Detectable Limit of Flame in AAS
MAL= Maximum Allowable Limit
Ref.: *FRG, 2012; **Fertilizer (Management) Regulation, 2007

Table 7. Nutrient and heavy metal contents in solubor collected from different areas of Bangladesh

Sample No.	Sampling location	B	Pb	Cd	Cr
		%		μg g^{-1}	
B_{1a}	Mymensingh	15.77	204.29	BDL	434
B_{1b}	Mymensingh	19.56	217.14	BDL	238
B_{1c}	Mymensingh	18.00	224.29	BDL	284
B_{2a}	Rajshahi	14.34	234.29	BDL	304
B_{2b}	Rajshahi	13.55	244.29	BDL	296
Mean		16.24	224.86	-	311
SD		2.51	15.41	-	73
CV (%)		15.46	6.85	-	23
Specification*/MAL**		20.9	100	10	500

BDL= Below Detectable Limit of Flame in AAS
MAL= Maximum Allowable Limit
Ref.: *FRG, 2012; **Fertilizer (Management) Regulation, 2007

Zinc sulphate fertilizer

Zinc is an essential trace element for plants, animals and humans found in virtually all food and portable water in the form of salts or organic complexes (Khan *et al.*, 2008). The concentration of Zn in fertilizer samples collected from different areas of Bangladesh was found within the range of 14.71 to 18.38% (Table 8). The concentration of Zn in all the samples had lower amount of nutrient than the standard limit (23%). Sulphur concentration in 3 collected samples had lower amount of nutrient than the standard limit (11%) and other 3 samples had higher amount of nutrient. Lead content in all the zinc sulphate heptahydrate fertilizer samples were 2 to 3 times higher than the MAL (100 μg g^{-1}). However, Cr content in three zinc sulphate heptahydrate fertilizer samples was lower than the MAL but exceeded in other three fertilizer samples. In one sample collected from Rajshahi, Cr was as high as 2276 μg g^{-1}. Cadmium content in all the samples was below the detectable limit.

Copper sulphate fertilizer

The fertilizer samples collected from different areas of Bangladesh contained 18.48 to 25.41% Cu (Table 9). Out of 6 samples ,only one sample meet the specification limit of Cu (25.4%) and all other samples contained less than specified amount of Cu. Lead content in all the copper sulphate fertilizer samples was four times higher than the MAL (100 μg g^{-1}). Repeated application of such contaminated fertilizers may lead to food chain contamination of Pb. Chromium content of five copper sulphate fertilizer samples was lower than MAL but exceeded in one fertilizer samples. However, Cd content in all the samples was below the detectable limit.

Table 8. Nutrient and heavy metal contents in zinc sulphate collected from different areas of Bangladesh

Sample No.	Sampling location	Zn	S	Pb	Cd	Cr
		%			μg g^{-1}	
Zn_1	Mymensingh	16.08	15.7	247.14	BDL	316
Zn_2	Bogra	16.06	14.0	254.29	BDL	304
Zn_{3a}	Rajshahi	18.38	14.6	262.86	BDL	676
Zn_{3b}	Rajshahi	14.71	8.5	281.43	BDL	686
Zn_{3c}	Rajshahi	18.14	10.1	291.43	BDL	2276
Zn_{3d}	Rajshahi	14.71	11.6	304.29	BDL	238
Mean		16.34	12.4	273.57	-	749
SD		1.60	2.8	22.40	-	773
CV (%)		9.79	22.6	8.18	-	103
Specification* / MAL**		23	11	100	10	500

BDL= Below Detectable Limit of Flame in AAS
MAL= Maximum Allowable Limit
Ref.: *FRG, 2012; **Fertilizer (Management) Regulation, 2007

Table 9. Nutrient and heavy metal contents in copper sulphate collected from different areas of Bangladesh

Sample No.	Sampling location	Cu	Pb	Cd	Cr
		%		μg g^{-1}	
Cu_{1a}	Mymensingh	25.41	385.7	BDL	220.0
Cu_{1b}	Mymensingh	18.48	392.9	BDL	140.0
Cu_2	Chittagong	21.46	398.6	BDL	140.2
Cu_3	Rajshahi	20.36	415.7	BDL	60.0
Cu_4	Bogra	23.40	412.9	BDL	84.0
Cu_5	Bogra	19.73	422.9	BDL	604.0
Mean		21.47	404.8	-	208.0
SD		2.55	14.5	-	201.7
CV (%)		11.88	3.6	-	96.9
Specification*/MAL**		25.40	100	10	500

BDL= Below Detectable Limit of Flame in AAS
MAL= Maximum Allowable Limit
Ref.: *FRG, 2012; **Fertilizer (Management) Regulation, 2007

Conclusion

Out of 54 samples, only 42 fertilizer samples (77.8%) had less than specified amount of nutrients and contained heavy metals like Pb and Cr, which were more than the maximum allowable limit in 67% and 47% of collected fertilizer samples, respectively. Cadmium content was below the detectable limit for all the fertilizer samples. In order to minimize the impact of adulteration of fertilizers on food security and safety, continuous monitoring is required.

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