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SOIL FERTILITY AND LEAF NUTRIENT STATUS OF MANGO ORCHARD SITES

SK. MUSFIQ-US-SALEHIN, GAZI MD. MOHSIN[1], TABASSUM FERDOUS[2], JOBAED RAGIB ZAMAN, MD. JASHIM UDDIN* AND MD. KHALILUR RAHMAN

Department of Soil, Water and Environment, University of Dhaka, Dhaka-1000, Bangladesh

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Abstract

Twenty soil and leaf samples from 20 orchards of mango (*Mangifera indica* L.) were collected from different locations of Rajshahi and Satkhira regions to evaluate soil texture, pH, organic matter, available and total nitrogen, phosphorus, potassium and sulfur of soils and the concentration of N and K in mango leaves. The pH of the soil varied from 6.3 - 7.9 and organic matter content varied from 0.72 - 3.60 per cent. The available nitrogen, phosphorus, potassium, and sulfur of the soils ranged from 190 - 510, 39 - 196, 36 - 206 and 25 - 235 mg/kg, respectively. The values of total N, P, K and S were 0.03 - 0.12, 0.022 - 0.210, 0.235 - 0.0.936 and 0.005 - 0.266 per cent, respectively. The dominant soil textural class was silty clay loam. The mean concentration of nitrogen (0.88%) and potassium (0.61%) in the leaf sample was low. The overall fertility status of the soils of Rajshahi and Satkhira regions in relation to mango cultivation is moderate.

Introduction

Mango (*Mangifera indica* L.) has become a major fruit crop of the tropics and sub-tropics, particularly in Asia, the most important fruit crop and where it has always been considered the king of fruits(1). In Bangladesh, its cultivation occupies an area of 37,830 hectares of land with an annual production of 116,1685 metric ton(2). Mango grows in almost all over Bangladesh but commercial and good quality mangoes grow in the north-western districts of the country. The leading mango growing districts of the country are Rajshahi, Chapainawabgonj and greater Dinajpur. Mango is seasonal cash crop of north-western region of Bangladesh. Mango exportation from Bangladesh is increasing day by day. In a study conducted(3) showed that present status of mango cultivation area increased converting the agricultural lands.

*Author for correspondence: <mjuddin66@yahoo.com>. [1]Department of Agriculture, Noakhali Science and Technology University, Sonapur, Noakhali-3814, Bangladesh. [2]Soil Resource Development Institute, Ministry of Agriculture, Dhaka-1215, Bangladesh.

The productivity of mango is hampered due to imbalanced use of fertilizers and pesticides[3]. Nutrition of fruit plants depends upon inherent ability of soils to supply nutrient elements. The key to mineral nutrition of the plants is the judicious use of fertilizers based on soil testing. Plant analysis is also used to confirm the suspected deficiencies and toxicities of nutrients and also to assess the efficacy of fertilizer doses[4]. Therefore, it is very important to focus on the soil nutrients availability and other properties pertaining to nutrients if mango production is to be increased. Total nitrogen, phosphorus, potassium and sulfur content in soils and their availability to the plants are vital properties of soil fertility. Soil nutrient of mango is an important part of orchard management practices[5]. Essential nutrients have specific role in the plant and their presence is must for the plant to complete its life cycle. Information on mineral nutrient status helps in diagnosis of nutritional problems and estimation of the fertilizer needs of the fruit trees[4]. To ascertain these, both soil and plant analyses are necessary as these are complementary to each other and one supplies the information that the other may not. The information on nutritional status of both soil and plant helps to understand about adequate fertilization of the orchards. Practically, no systematic work has been done on the nutritional status of mango orchards in Rajshahi and Satkhira regions of Bangladesh. A few reports are available in relation to the characteristics of mango orchard soils of Bangladesh[6,7]. The results obtained here may help in formulation of future nutritional status and in working out accurate fertilizer recommendations in the above mentioned regions.

The present experiment was undertaken to evaluate some physico-chemical properties of mango growing soils of Rajshahi and Satkhira regions and the concentration of nitrogen and potassium in the leaves of mango plants.

Materials and Methods

The fertility potential of some mango orchard soils as well as nitrogen and potassium content in leaf samples of different sites *viz.* Charghat, Dargapur, Mohanpur, Godagari, Tanore, Bagmara, Puthia, Paba, Bagha and Rajshahi Sadar Upazila of Rajshahi district and Kolaroa, Tala, Debhata, Assasuni, Satkhira Sadar Upazila of Satkhira district were evaluated. Twenty soil samples (0 - 15 cm depth) were collected from Rajshahi and Satkhira districts/regions. Soil sampling sites were Charghat, Daragpur, Rajshahi Sadar, Mohanpur, Godagari, Tanore, Bagmara, Puthia, Paba and Bagha Upazilas of Rajshahi district and Municipality, Fingri (Satkhira Upazila), Patkelghata, Sorulia (Tala Upazila), Joynagar, Gopinathpur (Kolaroa Upazila), Parulia, Kulia (Debhata Upazila) and Budhhata, Kulla (Assasuni Upazila) of Satkhira district. Soil samples were air-dried, visible roots and debris were discarded, massive aggregates were broken by using a wooden hammer, ground and sieved using 2 mm sieve. Samples were kept in polyethylene bags with proper labeling. Twenty leaf samples (terminal, green colour)

were collected from the above gardens, wiped with soft white clothes with distilled water, air-dried, oven-dried and powdered in a mechanical grinder and kept in polyethylene bags for laboratory analysis.

The particle size analysis of the soils was determined by hydrometer method[8] and textural class was determined by Marshall's triangle coordinate curve. The pH of the soil samples (soil and distilled water ratio 1 : 2.5) was measured by using a corning glass electrode pH meter. The organic matter content of soils was determined by wet oxidation method[9]. Available nitrogen was determined by extracting the soils with 1N KCl following the micro-Kjeldahl distillation method[10]. Available phosphorus extracted by 0.5M $NaHCO_3$ was determined colorimetrically by spectrophotometric after developing blue colour using ascorbic acid and potassium antimony tartrate as colour developing reagents [11] available K was extracted by 1N NH_4OAc and was determined by flame photometer and available sulphur was determined colorimetrically by using spectrophotometer after developing turbidity with $BaCl_2$ using Tween-80 as the suspending agent of the sulphate precipitation [12]. Total nitrogen in the soil samples was determined by micro-Kjeldhal steam distillation method after H_2SO_4 acid digestion[10]. Soil samples were digested with a mixture of concentrated HCl/HNO_3 (1 : 3)[13] for the determination of total P, K and S. Total phosphorus was determined by spectrophotometer using Vanadomolybdate yellow color method[14], total potassium was measured by a flame photometer and total sulphur was determined by spectrophotometer after developing turbidity with $BaCl_2$[12].

For total N and K analysis, 0.1 g ground leaf sample was digested on sand bath with 5 ml concentrated H_2SO_4 and 2 ml 4% (v/v) solution of perchloric acid (62%) in concentrated H_2SO_4. The digest was cooled and diluted to 100 ml with deionized water[15]. The concentration of N in leaf was determined by micro-Kjeldhal steam distillation method. The concentration of potassium in leaf was determined by a flame photometer.

Results and Discussion

Texture in the soils of Rajshahi district ranged from loam to silt loam and in Satkhira district, it varied from silty clay loam to silt loam (Table 1). The soils were coarser in nature having silty clay loam as the predominant texture in both Rajshahi and Satkhira regions (Table 1). The sand/silt ratio in the soils of Rajshahi ranged from 0.08 - 1.21 and the average silt/clay ratio varied from 1.47 - 3.26. The sand/silt ratio varied from 0.12 to 0.35 and silt/clay ratio ranged from 1.94 - 3.16 in the soils of Satkhira. It was reported that well drained sandy loam to loam soils provide the best environment for mango production[16].

Table 1. Particle size distribution of some selected soils of mango orchard sites of Rajshahi and Satkhira regions.

	Locations	% sand	% silt	% clay	Textural class	Sand/silt ratio	Silt/clay ratio
Rajshahi region	Charghat	44	42	14	l	1.05	3.0
	Daragpur	14	52	34	scl	0.27	1.53
	RajshahiSadar	6	70	24	scl	0.08	2.92
	Mohanpur	24	50	34	sl	0.48	1.47
	Godagari	16	50	34	scl	0.32	1.47
	Tanore	24	50	26	scl	0.48	1.92
	Bagmara	31	48	21	l	0.64	2.29
	Puthia	46	38	16	l	1.21	2.38
	Paba	19	62	19	sl	0.31	3.26
	Bagha	19	60	21	sl	0.32	2.86
Satkhira region	Municipality	19	50	31	scl	0.38	1.61
	Fingri	9	67	24	scl	0.13	2.79
	Patkelghata	9	60	31	scl	0.15	1.94
	Sorulia	10	60	26	scl	0.17	2.31
	Jaynagar	14	60	26	scl	0.23	2.31
	Gopinathpur	14	65	21	sl	0.22	3.10
	Parulia	19	60	21	sl	0.32	2.86
	Kulia	21	60	19	sl	0.35	3.16
	Budhhata	8	66	26	scl	0.12	2.54
	Kulla	16	63	21	sl	0.25	3.0

l : Loam , scl : Silty clay loam, sl : Silt loam.

The pH of soil samples of Rajshahi region varied from 6.3 to 7.9 having a mean value of 7.31 which indicate neutral soil reaction. Soils of Tanore and Bagmara showed pH of less than 7.0, all other Upazilas showed pH of greater than 7.0 (Table 2). Soils from Satkhira district showed pH of 6.4 - 7.5. Optimum pH varies from 5.5 - 7.8 for mango cultivation[16]. Organic matter ranged from 1.08 to 3.60% in Rajshahi and 0.72 to 3.24% in Satkhira region. According to the soil organic matter categorization as reported[17], the soil organic matter contents of surface soils were in the range of 1.08 to 3.60% was categorized as medium in the Rajshahi region and the organic matter contents between 0.72 and 3.24% in the Satkhira region categorized as medium. The available N in the soils of Rajshahi region ranged from 180 - 410 mg/kg with a mean of 294 mg/kg. In Satkhira region, available N ranged from 190 - 540 mg/kg with a mean of 340.5 mg/kg. Similar

observation on available nitrogen was reported in sandy loam soils of mango orchard field[4]. The total nitrogen content in the soils of Rajshahi region ranged from 0.03 to 0.12%. In Satkhira region, total nitrogen content ranged from 0.05 to 0.12% (Table 2). According to a study[17], the nitrogen content of the soil sample falls in low category probably due to nitrogen losses through leaching, surface runoff, denitrification, and ammonia volatilization etc.[18]. Similar nitrogen content in the mango orchard soils of Rangamati, Khagrachari and Bandarban Hill tracts were reported[7].

Table 2. Chemical properties of some selected soils of mango orchard sites of Rajshahi and Satkhira regions.

	Locations	pH	Organic matter (%)	Nitrogen		Phosphorus		Potassium		Sulfur	
				Avail-able (mg/)	Total (%)	Avail-able (mg/kg)	Total (%)	Avai-lable (mg/k)	Total (%)	Avail-able (mg/k)	Total (%)
Rajshahi region	Charghat	7.6	1.44	300	0.07	79	0.042	36	0.349	34	0.009
	Daragpur	7.9	1.08	290	0.05	39	0.038	85	0.376	95	0.034
	Sadar	7.7	2.76	200	0.10	86	0.084	100	0.513	80	0.019
	Mohanpur	7.0	1.80	280	0.06	97	0.210	103	0.714	102	0.187
	Godagari	7.3	3.60	300	0.12	46	0.044	172	0.834	120	0.083
	Tanore	6.3	2.28	390	0.08	63	0.087	206	0.493	170	0.138
	Bagmara	6.7	1.56	180	0.03	39	0.114	68	0.463	85	0.024
	Puthia	7.2	1.90	190	0.03	60	0.118	62	0.533	95	0.165
	Paba	7.5	2.52	410	0.07	60	0.136	77	0.463	75	0.022
	Bagha	7.7	2.28	400	0.06	67	0.177	97	0.936	137	0.266
	Municipality	6.4	0.72	310	0.12	196	0.117	163	0.355	55	0.027
Satkhira region	Fingri	6.7	2.40	190	0.10	60	0.033	45	0.331	45	0.017
	Patketghata	7.4	2.52	290	0.10	70	0.086	114	0.714	176	0.111
	Sorulia	7.2	3.24	320	0.11	109	0.144	201	0.694	185	0.167
	Joynagar	7.2	3.72	380	0.10	99	0.089	163	0.376	75	0.028
	Gopinathpur	7.4	2.04	510	0.07	117	0.121	131	0.343	90	0.014
	Parulia	6.8	2.28	305	0.07	109	0.133	77	0.269	203	0.095
	Kulia	6.7	3.00	400	0.06	98	0.135	71	0.563	235	0.167
	Budhhata	7.5	3.00	410	0.08	90	0.022	45	0.235	65	0.029
	Kulla	7.3	2.04	290	0.05	107	0.023	39	0.269	25	0.005
Mean		7.2	2.31	317.3	0.076	81.55	0.085	102.75	0.424	107.35	0.065

The available P in the soils of Rajshahi region ranged from 39 to 97 mg/kg with an average of 63.6 mg/kg. In Satkhira region, available P ranged from 60 to 196 mg/kg with an average of 105.5 mg/kg. The mean value for available P in the study site was 109 mg/kg. The total phosphorous content in the soils of Rajshahi region ranged from 0.038 to 0.21% with an average of 0.105%. In Satkhira region, total phosphorus content ranged from 0.022 to 0.144%. The phosphorous content of soil samples was low. The available K in the soils of Rajshahi region ranged from 36 to 206 mg/kg with an average of 100.6

mg/kg. In Satkhira region, available K ranged from 39 to 201 with an average of 104.9 mg/kg. The overall available K in Rajshahi and Satkhira regions were 102.75 mg/kg. The total potassium content in the soil samples was high. The total potassium content of Rajshahi region ranged from 0.349 - 0.93% whereas in Satkhira region it ranged from 0.23 - 0.714% (Table 2). The available sulfur content was 34 - 170 mg/kg in Rajshahi region and 25 - 235 mg/kg in Satkhira region, respectively. The average value of available S was 99.3 mg/kg in Rajshahi region and 115.4 mg/kg in Satkhira region. The total sulfur content in the soils of Rajshahi region ranged from 0.009 - 0.266% with an average of 0.111% whereas in Satkhira region, it ranged from 0.005 to 0.167% with an average of 0.064%.

The analysis of the leaf sample showed that the total nitrogen content of Rajshahi region ranged from 0.86 - 1.42% with an average of 1.116% and in Satkhira region, it ranged from 0.83 - 1.42% with an average of 1.340% (Table 3). The potassium content of the leaf samples ranged from 0.37 - 0.88% in Rajshahi region with an average of 0.65%. In

Table 3. The concentration of N and K in mango leaves of Rajshahi and Satkhira regions.

Location		Nitrogen (%)	Potassium (%)
Rajshahi	Charghat	1.42 ± 0.10	0.78 ± 0.26
	Daragpur	1.03 ± 0.11	0.46 ± 0.15
	Sadar	1.29 ± 0.14	0.81 ± 0.23
	Mohanpur	0.90 ± 0.44	0.37 ± 0.18
	Godagari	1.02 ± 0.173	0.88 ± 0.23
	Tanore	0.88 ± 0.41	0.61 ± 0.19
	Bagmara	0.86 ± 0.41	0.49 ± 0.16
	Puthia	1.16 ± 0.14	0.56 ± 0.18
	Paba	1.17 ± 0.12	0.86 ± 0.28
	Bagha	1.43 ± 0.10	0.67 ± 0.22
Satkhira	Municipality	1.18 ± 0.17	0.80 ± 0.26
	Fingri	1.01 ± 0.28	0.65 ± 0.20
	Patkelghata	0.91 ± 0.41	0.68 ± 0.22
	Sorulia	1.15 ± 0.13	0.55 ± 0.16
	Joynagar	1.41 ± 0.13	0.91 ± 0.30
	Gopinathpur	0.83 ± 0.16	0.66 ± 0.22
	Parulia	1.19 ± 0.12	0.79 ± 0.21
	Kulia	1.04 ± 0.12	0.76 ± 0.25
	Budhhata	1.20 ± 0.11	0.62 ± 0.20
	Kulla	1.42 ± 0.17	0.38 ± 0.12
Mean		0.88	0.61

case of Satkhira region the range was from 0.38 - 0.91% with an average of 0.68%. The overall concentration of N and K in the leaf sample was 0.88 and 0.61% in Rajshahi and Satkhira regions, respectively. The concentration of N and K was low in the leaf samples of Rajshahi and Satkhira regions. It was reported in a study that the leaves of mango plants of Rajshahi and Dhaka contained 0.63 - 1.85% nitrogen, 0.16 - 0.20% phosphorus, 0.51 - 0.89% potassium[6]. The percentage of N in mango leaf blades and petioles at different dates were 1.50 to 2.17 and 1.013 to 1.707, respectively[19]. A field experiment[20] was conducted to examine the effects of K fertilization on leaf K, nutrient yield and quality in pistachio (*Pistacia vera* **L.**). Pistachio trees exhibited highly fluctuating seasonal leaf K levels. Leaf K concentration was low (<10 g/kg) during spring flush, increased dramatically during fruit development and declined rapidly after harvest.

Queensland Department of Agriculture and Fisheries proposed an outline on optimum nutrient level in leaf of mango[21] (Table 4). The analyzed values were compared with this optimum soil e.g. soil pH, organic carbon, nitrogen, phosphorus, potassium, sulfur etc. and leaf level e.g. percent N and percent K, for mango fruits which indicates that the soils of Rajshahi and Satkhira regions are at moderate level to support mango production.

Table 4. Comparison of analyzed nutrient levels with optimum levels of soil and leaf samples of Rajshahi and Satkhira regions.

Elements	*For optimum soil levels	Analyzed nutrient levels
pH	5.5 - 7.0	6.3 - 7.9
Organic carbon (%)	1-3	0.72 - 3.72
Nitrogen (mg/kg)	<10	180 - 510
Phosphorus (mg/kg)	60 - 80	39 - 196
Potassium (meq/100gm)	0.25 - 0.4	0.10 - 0.52
Sulfur (mg/kg)	>12	25 - 203
	*Optimum leaf levels	
N (%)	1-1.5	0.83 - 1.43
K (%)	0.75-1.2	0.37 - 0.91

*Source: QDAF, 2015[21]

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