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Fertility status of soils in organically and conventionally managed Paddy fields of Shivamogga district in Karnataka, India

Bharath Patil, Ganapathi and KS Niranjana

Abstract

A survey was conducted during 2015-16 to study the effect of organic and inorganic farming practices on soil physical and chemical properties in paddy fields of Shivamogga district. Results of the soils collected from 0-20 cm depth was revealed that, practicing of organic farming recorded lower bulk density of soil, but higher maximum water holding capacity. The soil pH was slightly higher under organic farming. Higher soil organic carbon (8.28 g kg^{-1}) and CEC(18.76 cmol (p^+) kg^{-1}) was observed in organically managed paddy fields as compared to conventionally managed farms. The higher available nitrogen, phosphorus and potassium was recorded in organically managed farms with a mean value of 382.29 kg ha^{-1}, 85.31 kg ha^{-1} and 241.12 kg ha^{-1} respectively. The soils under organic farming recorded higher amount of exchangeable Ca (6.7 cmol (p^+) kg^{-1}), Mg (2.51 cmol (p^+) kg^{-1}) and available S (26.33 mg kg^{-1}) as compared to inorganic farming with mean value of 5.87 cmol (p^+) kg^{-1}), 2.46 cmol (p^+) kg^{-1} and 25.32 cmol (p^+) kg^{-1}. The farms under organic farming recorded higher in soil nutrient status and improved physical properties than conventional farming.

Keywords: soils, chemical properties, conventional farming.

Introduction

Organic farming systems rely on the management of soil organic matter to enhance the physical, chemical and biological properties of the soil, in order to optimize crop production. Conventional agriculture often relies on application of fertilizer, pesticides and other inputs. Although the benefits of organic manures application to soil in improving its physical, chemical and biological properties have been well known information on the changes that would take place on shifting from conventional farming system to organic farming system is lacking. Use of high analysis fertilizers and inadequate quantity of organics use has led to decline in soil fertility viz., secondary and micronutrients deficiencies and crop production capacity but organic farming improved the soil properties, nutrients supplying capacity and managing good environment health without any chemical hazards. Organic farming has improved food quality and safety, because the nutrients supply and pest's control methods are largely depends on biological process. Soil enzymes activities and microbial population are higher in organically managed farming when compared to the conventional and integrated managed farming (Carine Floch *et al.*, 2009) [10]. Soil fertility status of organic farming farms at Madhypradesh recorded higher than conventional farming farms (Ramesh *et al.*, 2008) [32]. As soil scientists, it is pertinent for us to understand what benefits are derived under organic farming over conventional farming. But there was little research data with non-systematic work available on the influence of organic farming practices on soil properties. Through the present study, an attempt has been made to elicit information on what happens when there is a continuous organic and inorganic practice of cultivation and how both the practices influence on soil physical and chemical properties.

Materials and Methods

The study mainly intended to convey, impact of organic and conventional farming on soil physical and chemical properties in paddy fields of Shivamogga district, Karnataka. The selected farms of shivamogga district from agro climatic zone-7 (Southern Transitional Zone) includes Bhadravathi, Shivamogga, Shikaripura and zone-9 (Hilly zone) includes Soraba, Hosanagara, Sagara and Thirthahalli taluks for the present investigation. Twenty one each soil samples collected from certified organic and conventional paddy farms. Three organic and three inorganic paddy farms were selected from each taluk where organically farmers practicing organic farming for five years or more for present investigation in addition to adjacent conventional farms. Surface soil samples (0-15 cm) were collected from both organic and conventional farms in three spot and pooled them to farm representative sample. Collected soil samples were processed and analyzed for physical and chemical properties by adopting standard procedure. Bulk density of soil by core sampler method (Piper, 1966) [29] and soil texture was determined by using international pipette method as described by Piper (1966) [29]. Maximum water holding capacity of soil by Keen's cup method (Keen's, 1921) [22], soil pH by potentiometric method and electrical conductivity (EC) was estimated by conductometric method as outlined by Jackson (1973) [17]. The soil organic carbon (0.2 mm sieved) was determined by Walkley and Black method (1934) [48] using diphenylamine indicator and cation exchange capacity of soil determined by taking 10 gram of soil and leached several times with neutral normal ammonium acetate solution followed by washing with alcohol to remove excess of the electrolytes. The adsorbed ammonium ions were replaced by potassium ions by leaching the soil with 10 per cent potassium chloride solution. Finally, in the leachate of KCl, ammonia was determined by distillation method as described by Page *et al.* (1982) [26]. Available nitrogen in the soil was determined by alkaline potassium permanganate method as described by Subbaiah and Asija (1956) [42]. Available phosphorus was extracted from soil by using Bray's No.1 extractant (0.03 N NH_4F + 0.025 N HCl) and the concentration of phosphorus in the extract was determined by chlorostannous reduced molybdophosphric acid blue colour in HCl system using spectrometric method (Jackson, 1973) [17]. Available potassium was extracted from the soils using neutral normal ammonium acetate in 1: 5 soil to water extractant ratio and the concentration of potassium present in the extract was determined by flame photometric method (Jackson, 1973) [17]. Available S was determined by turbidometric method (Black, 1965) [7]. The exchangeable calcium and magnesium were determined by leaching the soil with neutral normal ammonium acetate solution and calcium and magnesium in the leachate were determined by Versenate titration method (Jackson, 1973) [17].

Results and Discussion

***Soil physical properties**:* The bulk density of soils under organic paddy cultivation in different taluks of Shivamogga district ranged from 0.9 to 1.14 Mg m^{-3} and 0.91 to 1.42 Mg m^{-3} in conventional (inorganic) farming system (Table 1).The mean soil bulk density was lower under organic farming paddy fields (1.17 Mg m^{-3}) as compared to farms of inorganic (1.27 Mg m^{-3}) paddy cultivation. Sharma *et al*. (2000) [34] and Srikanth *et al.* (2000) [39] reported that, reduction in bulk density of soil in organic farming system over a conventional farming could be due to higher organic carbon and better soil structure as evidence from increase in water stable aggregates as well as effective pore space. Maximum water holding capacity of soils under organic and inorganic paddy cultivation in different taluks of Shivamogga district ranged from 17.89 to 44.13 and 13.36 to 41.03 per cent respectively. The mean values of maximum water holding capacity of soil was lower in inorganic farming paddy fields (28.24 %) as compared to organic (30.19 %) paddy cultivated farms. Organic farming and application of organic manure was attributed to buildup of organic matter in soil which improves the soil structure by increasing macro and micro porosity resulted in higher water holding capacity as reported by Qiong *et al.*(2014) [31]

Soil chemical properties

Soil pH, EC, OC and CEC

pH of soils under organically managed paddy cultivation in different taluks of Shivamogga district ranged from 4.25 to 5.82 and in conventional (inorganic) farming system of different taluks ranged from 3.67 to 6.06(Table 2). The mean pH was lower under inorganic farming paddy fields (4.82) as compared to organic (5.08) paddy cultivation. Soils under organic farming recorded comparatively higher soil pH compared to conventional farming (Table 1) indicates that the increase in pH with organic farming due to organic manures application is basically a source of basic cations particularly calcium. The soil pH increased due to continuous application of FYM due to deactivation of Fe3+ and Al3+ by chelating effect and release of basic cation through decomposition of organic manure (Grewal *et al*., 1981; Gajanana *et al*., 2005; Suresh Lal and Mathur, 1988) [16, 14, 40]. The EC of soils under organic paddy cultivation in different taluks of Shivamogga district ranged from 0.001 to 0.24 dS m^{-1} and conventional (inorganic) farming paddy fields ranged from 0.019 to 0.183 dSm^{-1} (Table 2). Practice of organic farming has increased the soil EC in small per centage may be attributed to release of calcium from organic materials and subsequent formation of some of the soluble salts (Chahal *et al.,* 1984; Bhriguvanshi, 1988; Jessica *et al.,* 2000; Sarwar *et al*., 2010) [11, 6, 20, 33]. The reason for relatively higher soluble salt content observed in the FYM plots as compared to the plots treated with only chemical fertilizers could be attributed to the higher solubilization by the production of organic acids.

The SOC of soils under organic paddy cultivation in different taluks of Shivamogga district ranged from 3.25 to 12.72 g kg^{-1} and conventional (inorganic) farming system ranged from 1.77 to 11.54 g kg^{-1}. The mean SOC is lower under inorganic farming soils (6.40 g kg^{-1}) as compared to organic (8.28 g kg^{-1}) paddy cultivation (Table 3). The results of organic carbon content of soils indicated that it was higher in organic farming in paddy fields. The increase in organic carbon content of soils under organic farming was quite obvious since the carbonaceous material contribute to soil organic carbon after decomposition. These observations are in agreement with the findings of Grewal *et al.* (1981) [16] and Kaushik *et al.* (1984) [21]. A build up of organic carbon in soil due to continuous application of organic manure and crop residue subsequent decomposition of these residues by higher microbial population might have resulted in increased soil organic carbon as reported by several workers Gattani *et al*. (1976) [15]; Sinha *et al.* (1983) [38]; Patiram and Singh (1993) [27]; Bhandari *et al*. (1992) [4] and Mathur (1997) [25]. Similar results were obtained by Krishnamurthy (2010) [23] where in regular addition of organics such as FYM and compost increased the organic carbon status in soils. Sharma *et al.* (1999) [35] reported that application of FYM and crop residue alone is effective in building up of soil fertility with respect to organic carbon content of the soil in long run.

The CEC of conventional (inorganic) farming system in different taluks ranged from 8.70 to 34.07 cmol (p+) kg^{-1} and soils under organic paddy fields in different taluks of Shivamogga district ranged from 16.01 to 36.71 cmol (p+) $kg^{-1.}$ The soils under organic farming recorded higher cation exchangeable capacity (CEC) than soils under conventional farming paddy (Table 3). The increase in CEC was due to improvement in soil organic matter content and pH of the soil after decomposition of organic materials. A slight increase in organic matter content can enhance the CEC of the soil to a greater extent because of its high CEC 200-400 cmol (P+) kg-1 (Gattani *et al*., 1976) [15]. Singh *et al.* (1980) [36] also observed the raise in CEC due to increase in organic matter of soil by application of organic manures. Several workers also reported the same results (Patiram and Singh, 1993; Bellakki and Badanur, 1997 and Bulluck *et al*., 2002) [27, 9].

Available NPK: The soil available nitrogen under organic paddy cultivation in different taluks of Shivamogga district ranged from 211.18 to 550.46 kg ha^{-1} and in conventional (inorganic) farming paddy fields ranged from 131.12 to 499.40 kg ha^{-1}. The available nitrogen was lower under inorganic farming paddy fields (294.12 kg ha^{-1}) as compared to organic (382.29 kg ha^{-1}) paddy farms. Higher available N was recorded in organically managed paddy fields might be due to production of appreciable quantities of acids during decomposition of organic matter mineralizes the complex organic substance, which intern would contribute to N pool and greater multiplication of soil microbes caused by the addition of organic materials which mineralize organically bound N to inorganic form (Bellakki and Badanur, 1997; Mathuvel *et al.*, 1990) [24].

The available phosphorus of soils under organic paddy cultivation in different taluks of Shivamogga district ranged from 63.06 to 120.75kg ha^{-1} and in conventional (inorganic) farming fields in different taluks ranged from 40.35 to 76.61kg ha^{-1}. The result on available phosphorus content was higher in soil under organic farming as compared to conventional farming (Table 4). An increase in available phosphorus content due to incorporation of FYM and other organic manures enhanced solubilization of native phosphorus, faster rate of P mineralization (Brar *et al*., 2004) [8] and added phosphorus by the decomposition product of organic manures **(**Singh *et al.*, 1982) [37]. Similar results was obtained by Venkateshwarulu, 1983 [47]; Vasanthi and Kumaraswamy, 1996 [45]; Sudhir *et al.*, 1998 [41]; Gajanan *et al*., 1999 [13] and Ramesh *et al.*, 2008 [32]. Increase in available phosphorus due to FYM application may also be due to coating of organic materials on sesquioxides that reduces phosphate fixing capacity of soil. The appreciable buildup of available phosphorus status in organic manure applied plot may be attributed to the influence of organic manure in increasing the labile phosphorus in soil through complexing cations like Ca+2 and Mg2+ which are mainly responsible for fixation of phosphorus (Bhriguvanshi, 1988) [6]. Tondon (1987) [43] attributed the increase in available P with FYM application to the contribution of P by the organics to the soil available pool and phosphate fixing capacity of soil. Similar observations were also reported by Bharadwaj and Omanwar (1994) [5]. Manure application may alter the composition of soluble and exchange ions in the soil and, possibly, the nature and formation of minerals in the solid phase, that control P solubility in soil solution (Paul and Clark, 2003). Organic acids, Mg and Si can inhibit crystallization of stable Ca-P minerals, resulting in high P solubility in these soils as reported by Karthikeyan (2004).

The available potassium of soils under organic paddy cultivation in different taluks of Shivamogga district ranged from 183.05 to 300.51 kg ha^{-1} and in conventional (inorganic) farming paddy fields ranged from 172.97 to 264.9 kg ha^{-1}. Soils under organic farming recorded higher available potassium than conventional farming. The increase in available potassium in organic farming soils could be attributed to the direct addition of potassium to available pool of the soil from organic manures applied to soil and which contain various organic acids might have aided in release of non-exchangeable K to water soluble forms **(**Chitra and Janaki, 1999) [12]. Similar observation of increase in available potassium due to addition of organic manures were made by Grawal *et al*. (1981) [16], Prasad *et al*. (1996) [30], Sudhir *et al*. (1998) [41]. FYM is not only direct and ready source but helps in minimizing the leaching loss of K by retaining K ions on exchangeable sites (Bansal, 1992). The beneficial effect of FYM on the available potassium might also be ascribed to the reduction of potassium fixation (Tandon, 1988).

Ca, Mg and S

It was observed that the exchangeable calcium and magnesium of soils under organic paddy cultivation in different taluks of Shivamogga district ranged from 1.6 to 18.1 cmol (p+) kg^{-1} and 0.2 to 7.0 cmol (p+) kg^{-1} respectively (Table 5). In conventional (inorganic) farming system in different taluks recorded 1.0 to 17.8 cmol (p+) kg^{-1} and 0.1 to 6.9 cmol (p+) kg^{-1} of calcium and magnesium respectively. The mean exchangeable calcium (5.87 cmol (p+) kg^{-1}) and magnesium(2.46 cmol (p+) kg^{-1}) was lower under inorganic farming paddy fields and as compared to organic (6.7 cmol (p+) kg^{-1}) and (2.51 cmol (p+) kg^{-1}) paddy farms. Higher exchangeable Ca and Mg was recorded in organically managed soils was due to organic matter upon its decomposition by producing organic acids which enhances solubility of native Ca and its retention by organic colloids (Srikanth *et al*., 2000; Prasad *et al*., 1996) [39, 30].

Available sulphur of soils under organic paddy farms in different taluks of Shivamogga district ranged from 23.3 to 34.0 mg kg^{-1} and in conventional (inorganic) farming system ranged from 17.2 to 31.1 mg kg^{-1} (Table 5). The soils under organic farming recorded higher values of available sulphur content than soils under conventional farming due to the addition of sulphur through the organic manure as S containing amino acids applied to the soil. Increase in available sulphur in soils of organic farming was due to the addition of Sulphur through the organic manure as S containing amino acids applied to the soil (Jagadeesh, 2000) [18]. The results are in agreement with the findings of Ayuba *et al.* (2005) [1]; Vasundhara (2006) [44] and Javed (2012) [19]. Vadiraj *et al.* (1992) [46] attributed the increase in available S content to the release of organic bound sulphur through mineralization. An addition of higher quantity of organic manure for longer period was probably responsible for build-up of available sulphur in those soils.

From the results of the research it was concluded that the soil fertility status was found higher in organic paddy farms as compared to inorganic farms was mainly due to improved physical properties of soils influenced favorably by the organic farming practice.

Table 1: Effect of organic and inorganic farming practices on soil bulk density and maximum water holding capacity soils in paddy fields of different taluks in Shivamogga district

Taluk	Location of farms(Villages)	Organic		Inorganic	
		BD	MWHC	BD	MWHC
		Mg m^{-3}	%	Mg m^{-3}	%
Shivamogga	Hosudi	1.18	35.06	1.37	30.62
	Dummalli	1.21	36.00	1.42	29.79
	Honnavile	1.00	37.03	1.37	25.03
Thirthahalli	Thirthahalli	1.13	22.56	1.42	21.08
	Chikkodbailu	1.14	28.30	1.27	25.36
	Kuruvalli	1.17	24.20	1.16	30.625
Hosanagara	Solagere	1.19	23.45	1.40	20.52
	Kuliyadi	1.03	17.89	0.91	15.36
	Mathimane	1.00	20.45	1.30	21.36
Sagara	Veerapura	1.28	35.75	1.22	28.00
	Hirethota	1.19	33.71	1.16	29.69
	Chikkabilagungi	1.14	36.87	1.19	30.00
Bhadravathi	Thadasa	1.19	33.75	1.25	40.68
	Agenahalli	1.29	30.85	1.30	41.03
	Holebairnalli	1.24	30.85	1.23	35.75
Shikaripura	Churchigundi	1.18	31.76	1.25	29.18
	Chikarasipura	1.17	31.76	1.29	28.00
	Gidadahalli	0.90	44.13	1.21	25.88
Soraba	Hale sorabha	1.33	25.88	1.39	23.45
	Kanbail	1.41	28.00	1.37	25.88
	Sorabha	1.21	25.88	1.20	35.75
Range		0.90-1.41	17.89-44.13	0.91-1.42	15.36-41.03
Mean		1.17	30.19	1.27	28.24

BD: Bulk Density MWHC: maximum water holding capacity

Table 2: Effect of organic and inorganic farming practices on pH and Electrical conductivity of soils under paddy fields of different taluks in Shivamogga district

Taluk	Location of farms(Villages)	Organic		Inorganic	
		pH(1:2.5)	EC(dSm^{-1})	pH(1:2.5)	EC (dSm^{-1})
Shivamogga	Hosudi	4.28	0.138	4.21	0.171
	Dummalli	4.48	0.185	4.53	0.183
	Honnavile	5.10	0.175	4.93	0.162
Thirthahalli	Thirthahalli	5.78	0.108	4.59	0.078
	Chikkodbailu	4.29	0.095	4.40	0.076
	Kuruvalli	4.42	0.084	4.13	0.078
Hosanagara	Solagere	5.01	0.073	5.03	0.026
	Kuliyadi	5.55	0.083	5.50	0.024
	Mathimane	4.93	0.08	5.00	0.023
Sagara	Veerapura	5.57	0.062	5.19	0.084
	Hirethota	5.22	0.068	5.09	0.078
	Chikkabilagungi	5.61	0.077	5.13	0.081
Bhadravathi	Thadasa	4.25	0.086	3.67	0.093
	Agenahalli	4.30	0.088	4.00	0.104
	Holebairnalli	5.47	0.010	3.74	0.100
Shikaripura	Churchigundi	5.82	0.244	6.06	0.093
	Chikarasipura	5.73	0.15	6.00	0.096
	Gidadahalli	5.02	0.085	5.02	0.084
Soraba	Hale sorabha	5.66	0.024	4.66	0.021
	Kanbail	4.82	0.027	4.78	0.019
	Sorabha	5.50	0.053	5.55	0.05
Range		4.25-5.82	0.01-0.244	3.67-6.06	0.019-0.183
Mean		5.08	0.095	4.82	0.082

EC: Electrical conductivity

Table 3: Effect of organic and inorganic farming practices soil organic carbon and cation exchange capacity of soils under paddy fields of different taluks in Shivamogga district

Taluk	Location of farms (Villages)	Organic		Inorganic	
		SOC (g/kg)	CEC capacity [cmol (p$^+$) kg^{-1}]	SOC (g/kg)	CEC [cmol (p$^+$) kg^{-1}]
Shivamogga	Hosudi	10.99	18.47	7.42	13.06
	Dummalli	12.72	19.33	9.95	13.50
	Honnavile	7.72	18.64	6.22	14.71
Thirthahalli	Thirthahalli	9.17	9.54	8.01	8.70
	Chikkodbailu	10.39	11.72	7.72	9.12
	Kuruvalli	11.28	10.36	10.09	8.92
Hosanagara	Solagere	10.69	16.20	8.31	15.91
	Kuliyadi	9.05	17.14	3.88	14.11
	Mathimane	12.32	19.50	11.54	17.41
Sagara	Veerapura	6.53	17.61	4.02	16.61
	Hirethota	7.42	18.10	5.92	14.51
	Chikkabilagungi	6.38	15.41	4.88	12.51
Bhadravathi	Thadasa	7.54	16.20	7.54	13.16
	Agenahalli	9.17	14.71	6.91	13.02
	Holebairnalli	8.73	16.08	8.14	14.41
Shikaripura	Churchigundi	8.43	36.71	6.21	34.07
	Chikarasipura	4.88	32.97	3.03	30.00
	Gidadahalli	3.25	34.37	1.77	31.95
Soraba	Hale sorabha	5.32	14.12	4.29	11.48
	Kanbail	5.18	16.16	2.96	10.83
	Sorabha	6.80	16.01	5.62	11.62
Range		3.25-12.72	16.01-36.71	1.77-11.54	8.7-34.07
Mean		8.28	18.76	6.40	15.69

SOC: Soil organic carbon

Table 4: Soil available N, P_2O_5 and K_2O status under organic and inorganic Paddy fields of Shivamogga **district**

Taluks	Location of farms(Villages)	Paddy					
		Organic			Inorganic		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
		Kg/ha			Kg/ha		
Shivamogga	Hosudi	475.60	91.40	298.24	321.10	50.36	264.90
	Dummalli	550.46	81.44	213.05	430.59	61.3	194.36
	Honnavile	334.08	93.66	265.2	178.29	60.34	226.50
Thirthahalli	Thirthahalli	396.83	76.73	238.93	346.63	70.10	226.85
	Chikkodbailu	449.63	63.06	238.23	334.08	40.35	231.53
	Kuruvalli	488.15	75.04	240.61	436.65	68.46	230.08
Hosanagara	Solagere	462.61	91.30	296.35	359.62	69.15	219.45
	Kuliyadi	391.64	96.40	225.62	267.91	76.61	201.60
	Mathimane	533.15	97.10	225.36	499.40	71.97	220.54
Sagara	Veerapura	382.59	91.69	218.19	173.96	60.28	176.73
	Hirethota	321.10	88.30	259.39	256.19	51.40	233.18
	Chikkabilagungi	276.09	89.43	243.64	211.18	62.53	226.23
Bhadravathi	Thadasa	326.29	120.75	183.05	326.29	75.51	172.97
	Agenahalli	396.83	91.34	250.65	299.03	65.35	195.14
	Holebairnalli	377.79	97.33	197.10	352.26	61.47	182.78
Shikaripura	Churchigundi	364.81	75.04	300.51	268.74	44.63	217.71
	Chikarasipura	211.18	75.32	264.78	131.12	56.89	214.22
	Gidadahalli	240.64	74.41	256.70	176.59	54.23	233.83
Soraba	Hale sorabha	330.22	73.63	210.68	285.65	49.74	216.36
	Kanbail	324.16	75.89	215.19	278.09	45.64	220.19
	Sorabha	394.27	72.22	220.36	243.21	51.25	219.38
Range		211.18 - 550.46	63.0 - 120.7	183.05 - 300.51	131.12 - 499.40	40.35 - 76.61	172.97 - 264.9
Mean		382.29	85.31	241.04	294.12	59.40	215.45

Table 5: Soil exchangeable Ca, Mg, Ca/Mg and available Sulphur status in organic and inorganic Paddy fields of Shivamogga district

Taluks	Location of farms (Villages)	Paddy							
		Organic				Inorganic			
		Ca	Mg	Ca/Mg	S	Ca	Mg	Ca/Mg	S
		cmol (p^+) kg^{-1}			mg/kg	cmol (p^+) kg^{-1}			mg/kg
Shivamogga	Hosudi	6.1	1.9	3.21	25.6	3.5	1.4	2.50	25.8
	Dummalli	4.9	1.2	4.08	34.0	6.9	2.7	2.55	25.3
	Honnavile	4.7	1.8	2.61	27.5	4.9	1.8	2.72	26.1
Thirthahalli	Thirthahalli	2.5	0.7	3.57	26.5	1.0	0.5	2.00	25.6
	Chikkodbailu	2.5	0.7	3.57	24.8	3.0	0.1	30.00	25.0
	Kuruvalli	2.8	0.2	14.00	25.1	2.0	0.5	4.00	21.9
Hosanagara	Solagere	1.6	0.5	3.20	25.8	1.1	0.3	3.66	26.3
	Kuliyadi	2.4	1.1	2.10	24.1	2.8	0.7	4.00	17.2
	Mathimane	1.6	1.1	1.45	24.5	2.1	0.6	3.50	21.6
Sagara	Veerapura	3.0	0.4	7.50	25.3	2.4	1.1	2.18	29.4
	Hirethota	2.1	0.6	3.50	25.7	2.1	1.4	1.50	25.4
	Chikkabilagungi	2.5	1.5	1.66	26.4	2.5	1.0	2.50	27.1
Bhadravathi	Thadasa	7.3	2.0	3.65	27.6	5.1	2.1	2.42	26.1
	Agenahalli	6.3	2.1	3.00	27.7	6.1	2.6	2.34	24.6
	Holebairnalli	7.8	2.1	3.71	26.6	6.0	2.1	2.85	27.5
Shikaripura	Churchigundi	12.4	4.6	2.69	25.5	6.9	2.0	3.45	26.6
	Chikarasipura	16.1	7.0	2.30	27.8	15.2	5.9	2.57	26.6
	Gidadahalli	14	6.5	2.15	25.4	13.1	4.8	2.72	31.1
Soraba	Hale sorabha	7.2	0.9	8.00	23.3	3.2	0.6	5.33	22.1
	Kanbail	7.0	3.3	2.12	29.2	5.0	2.26	2.21	27.8
	Sorabha	3.8	1.9	2.00	23.7	6.9	3.9	1.76	21.6
Range		1.6 -18.1	0.2-7.0	1.45-14.00	23.3-34.0	1-17.8	0.1 -6.9	1.5-30	17.21-31.1
Mean		6.7	2.51	3.81	26.33	5.87	2.46	4.13	25.32

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