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Evaluation of soil fertility status in Sriganganagar district of Rajasthan

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Abstract
The soil survey entitled "Evaluation of soil fertility status in Sriganganagar district of Rajasthan" was undertaken to assess fertility status of soils in Gharsana tehsil of Sriganganagar district. Eighty surface (0-15 cm depths) soil samples were collected from different villages of Gharsana tehsil. The fertility status of soils were categorized on the basis of the pH, EC, organic matter, CEC, $CaCO_3$, available NPK and micronutrient into three classes (viz: low or deficient, medium and high or sufficient and majority of soils were loamy sand (95 per cent) in texture, normal (EC <1.0 dSm^{-1}), strong alkalinity problem (86.25 per cent) and calcareous (50 per cent) in nature. Available nitrogen and phosphorus status of soils of Gharsana tehsil were 100 per cent and 45 per cent deficient, respectively. The soil micronutrient status of Gharsana tehsil were also poor. In general, the zinc and iron were 100 per cent and copper content was 97.50 per cent deficient where as manganese status was sufficient in soils. It was found that majority of soils of the study area are poor in fertility.

Keywords: Soil fertility, macronutrient, micronutrient

Introduction
Soil characterization in relation to evaluation of soil fertility status of the soil of an area or region is an important aspect in context of sustainable agriculture production. The most important constituents in soil is organic matter, an appreciable amount of organic matter in soil tremendously increase soil fertility. Decay of organic matter release nitrogen, phosphorus and mineral nutrients in a form available to plant. Availability of N, P, K, secondary and micronutrients induce better germination of seeds and hence subsequent better growth and stronger root development. Agriculture activities change the soil chemical, physical and biological properties. The core constraints in relation to land use include, depletion of organic matter due to wide spread use of biomass as fuel, depletion of macro and micro nutrients, removal of top soil by erosion, change of physical properties and increased soil salinity (IFPRI, 2010). The Gharasna tehsil comes under Agro-climatic zone l B of Rajasthan (Irrigated North Western Plain), being Aeolian are characterized by light texture, low organic carbon content, high pH, low CEC and salinity/alkalinity problems (Shyampura *et al.* 2002). Aeolian soils are coarse textured, deep calcareous with low fertility status their hydraulic conductivity is very high, water holding capacity is low and is highly susceptible to wind erosion (Dhir, 1982).These soil conditions are not favorable for adequate availability of micronutrients (Yadav and Meena, 2009) [14]. The deficiency of micronutrients has become major constraint to productivity, stability and sustainability of soils (Bell and Dell, 2008) [1]. Due to use of chemically pure high analysis fertilizers and adoption of modern improved agricultural technology, depletion of nutrients is becoming faster and deficiencies of sulphur and certain micronutrients are also observed commonly (Katyal and Sharma, 1979). Uptake of micronutrient is affected by the presence of major nutrients due to either negative or positive interaction (Fageria, 2001). There for in the study area, management of soil available nutrients of optimizing crop yield is of paramount importance.

Materials and Methods
Gharsana tehsil is located in north-west part of the Sriganganagar district (Rajasthan) and situated between 29°02' north latitude and 73°05' east longitude and elevation of 156 m from mean sea level. It is a part of semi-arid belt of Rajasthan having geographical area of 1589.33 km^2.

It is surrounded by the tehsil Anupgarh in north and Chhatargarh, pugal and khajuwala tehsil of Bikaner district in south east and western border touches Fort Abbas tehsil of Bahawalnagar district of Pakistani Punjab. The study area lies in the agroclimatic zone- Ib. The climate of the area is typically semi-arid. Rainfall and temperatures are the two main elements of the climate. The rainfall is seasonal and not properly distributed and it varies between 100 to 350 mm annually which is mostly received during the months of July to September. In summer maximum temperature ranges between 37^0C to 49^0C and in winter the minimum temperature varies from 1^0C to 10^0C and sometimes it falls below 0^0C. Weather hazards are also not uncommon in this region; like storms during summers, fog during winters and nights are frosty. To evaluate the fertility status in area eighty farmer field selected and representative composite soil surface samples were collected with the help of a wooden khurpi. Soil samples were air-dried, passed through 2 mm sieve and stored in properly labeled plastic bags for physical and chemical analysis.

Results and Discussion

Physico-chemical properties of soil

$CaCO_3$

The calcium carbonate content in soils ranged between 2.80 to 7.65 per cent with mean value of 4.76 per cent. Calcium carbonate accumulation is considered to be an important pedogenic feature of desert soil (Boul *et al.*1997). The accumulation of $CaCO_3$ in soils might be due to semi-arid climatic conditions and drainage problems of the area. In arid and semi arid regions, rainfall is less as compared to annual evapo-transpiration; hence, less water is available for the leaching of insoluble carbonates and bicarbonates of calcium. This may have facilitated the accumulation of $CaCO_3$ in these soils. Similar results were also reported by Qureshi *et al.* (1996), and Chohan *et al.* (2015).

Organic carbon

The organic carbon content in soils ranged between 0.04 to 0.29 per cent with mean value of 0.15 per cent.On the basis of limits suggested by Muhr *et al.* (1965) all the soil samples under investigation rated low (< 0.5 per cent) in the soil organic carbon content. The very low organic carbon content of these soils may be attributed to high temperature, low rainfall, scanty and scrub vegetation cover and light texture of the soils. High temperature and good aeration in these soils increased the rate of oxidation of organic matter resulting in the reduction of soil organic carbon content. The results of the present investigation are in close proximity with the findings of Yadav and Meena (2009) [14].

Soil reaction (pH)

In case of soil samples pH value varied from 7.5 to 9.87 with mean value 8.82. Further reveal that 13.75 per cent and 86.25 per cent soil samples of Gharsana tehsil were moderately alkaline and highly alkaline in nature. The relative high pH of the soils might be due to the presence of high degree of base saturation. Similar results were also reported by Lal and Sharma (1975) and More *et al.* (1988).

Electrical conductivity (EC)

The EC in soil ranged between 0.04 to 2.84 dSm^{-1} with mean value of 0.53 dSm^{-1}. On the basis of EC limits suggested by Muhr *et al.* (1965) for judging salt problem of soils, the 97.5 per cent soils of studied area were found normal range (0.8 dSm^{-1}) indicating the salinity is not a problem in these soils. This might be due to inflow of soluble salt through with good quality irrigation water (canal water) and good drainage conditions. Similar findings were also reported by Gupta (2003).

Cation exchange capacity (CEC)

Under cultivation CEC ranged between 5.4 cmol. (p^+) kg^{-1} to 11.61 cmol. (p^+) kg^{-1} with mean value 8.19 cmol. (p^+) kg^{-1}. These soils have low CEC values and this might be due to their coarse texture, low organic matter content, presence of high amount of $CaCO_3$ and pre-dominance of 1:1 type clay minerals. The soils of Gharsana tehsil were mostly low in organic carbon, therefore, Cation exchange capacity primarily depends upon the amount of finer fractions and type of clay minerals present in these soils (Satyavathi *et al.* 1994).

Available nitrogen

The available nitrogen in soils under cultivation ranged from 54.1 to 168.14 kg ha^{-1} with a mean value of 116.13 kg ha^{-1}. On the basis of criteria, suggested by Subbiah and Asija (1956) all the soils samples were found deficient in available nitrogen. The low level of available nitrogen may be ascribed to several factors, including low organic carbon, high pH and $CaCO_3$ content. These might have resulted in decomposition and nitrogen mineralization's favoring higher ammonia volatilization losses, reduced nitrification and subsided activity of nitrogen fixing microbes. Similar findings were also reported by Kumar *et al.* (2014).

Available phosphorus

Phosphorus content of the soil under crop varied from 12.13 to 46.59 kg P_2O_5 ha^{-1} with a mean value 29.43 kg P_2O_5 ha^{-1}. Considering the available phosphorus (P) rating values that is, low (<28 kg P_2O_5 ha^{-1}), medium (28-56 kg P_2O_5 ha^{-1}), and high (>56 kg P_2O_5 ha^{-1}) as suggested by (Ghosh *et al.* 1983). It was observed that 46.25 per cent soils are low, 53.75 per cent soils are medium with respect to available phosphorus status of studied area. The variation in available phosphorus appears to be due to marked variation in organic carbon, $CaCO_3$ and other soil characteristics. Similar results were reported by Singh and Rathore (2013) [11].

Available potassium

Available potassium ranged between 212.92 to 310.22 kg K_2O ha^{-1} with a mean value of 255.52 kg K_2O ha^{-1}. On the basis of limits, 80 per cent soils (64 soil samples) were medium and 20 per cent (16 samples) were high in respect to available potassium content, of Gharsana tehsil of Sri Ganganagar district. It might due to the presence of most of mica (biotite and muscovite both) in finer fraction (<0.002mm size). The results suggest the K availability may not be limiting factor except in soils falling in the medium category in which crops might benefit by small application of K. However, there is a need for carrying out soil test crop response studies in soils containing various level of available K. The similar results are found by Kumar *et al.* (2014) [15].

Zinc

The zinc content in area ranged between 0.20 to 0.60 ppm with a mean value of 0.39 ppm. On the basis of the critical limits suggested by Takkar and Mann (1975) (< 0.6 ppm for deficient, 0.6 to 1.2 ppm for marginal and more than 1.2 ppm for sufficient) all the soil samples were deficient in available zinc. It has also been reported that organic matter plays an important role in controlling availability of zinc particularly in alkaline soils (Das, 2000) might be due to it provides chelating agents for solubilizing insoluble zinc compounds, formed Carbonic acid due to the decomposition of organic matter which is helpful to lower the pH of soil solution and it protects the conversion of soluble zinc into insoluble form. Hence, it is less subjected to fixation reactions. Similar types of results have also been reported by Shukla *et al.* (2015) [10].

Copper

It ranges between 0.02 to 0.4 ppm with a mean value of 0.06 ppm. According critical limits (0.2 ppm) suggested by Lindsay and Norvell (1978), 97.5 per cent soils were deficient. Its availability was found to decrease significantly with increase in sand content because the coarseness of soil texture reduces the adsorption of Cu^{2+} ions on exchange sites. On the same line, the availability of copper is significantly reduced at high pH. This might be due to precipitation of Cu^{2+} ions as relatively insoluble hydroxides. Thus, newly formed hydroxides, either would have become the part of lattice or occluded with the hydroxides of Fe, Al and Mn (Lindsay and Norvell, 1978). Similar types of results have also been reported by Mondal *et al.* (2015) [8].

Iron

The iron content of the soil varied from 1.5 to 4.40 ppm. On the basis of critical limits suggested by Lindsay and Norvell (1978) for DTPA extractable iron (4.5 ppm), 100 per cent soil samples are deficient in available iron under the crops. the availability of iron enhanced significantly with increase in organic matter might be due to it is helpful in improving soil structure and aeration, protects the oxidation and precipitation of iron into unavailable forms and supply soluble chelating agents which increase the solubility of iron compounds. Similar findings were also reported by Patel *et al.* (2015).

Manganese

In soils it ranges from 5.36 to 6.00 ppm with a mean value of 5.75 ppm. Considering 1.0 ppm as critical limits for manganese deficiency (Lindsey and Norvell, 1978), 100 per cent soil samples is found sufficient in available manganese. The variation observed in available manganese among different soils might be the result of variable soil factors (pH, OC, CEC, $CaCO_3$ etc.). The higher content of DTPA extractable manganese in the soils having more percent of finer fraction was found because increase in finer proportion in soils offered greater exchange sites for holding Mn^{2++} on it. Increase in available form of manganese with the increase in finer fraction of the soil was also reported by Dhamak *et al.* (2014).

Table 1: Soil chemical characteristics of Gharsana tehsil in Sriganganagar district of Rajasthan

S. no	Sample code no.	pH	EC (dSm^{-1})	Organic carbon %	$CaCO_3$ (%)	CEC	Nutrient status of soil (Kg ha^{-1})						
							Macro nutrients			Micro nutrients			
							N	P	K	Zn	Fe	Cu	Mn
1	S_1	8.81	0.60	0.22	4.00	5.40	55.16	33.15	237.85	0.30	2.00	0.02	5.83
2	S_2	8.73	0.40	0.18	6.00	6.40	55.16	42.11	224.72	0.51	1.80	0.06	5.78
3	S_3	8.72	0.32	0.21	5.40	7.40	145.00	35.44	250.28	0.53	1.90	0.04	5.84
4	S_4	8.73	0.04	0.23	5.80	11.40	151.70	46.59	295.21	0.50	1.70	0.02	5.85
5	S_5	8.25	0.80	0.22	6.10	7.40	150.46	36.73	284.10	0.36	2.70	0.04	5.78
6	S_6	7.50	0.80	0.19	5.70	6.20	151.70	41.21	290.88	0.43	4.00	0.02	5.80
7	S_7	7.54	0.20	0.11	6.40	6.50	93.77	32.25	280.11	0.44	3.20	0.06	5.60
8	S_8	9.67	0.83	0.12	5.11	6.40	74.47	27.77	235.94	0.29	2.90	0.06	5.68
9	S_9	8.83	0.49	0.14	5.90	10.40	152.64	25.08	282.91	0.41	3.00	0.02	5.70
10	S_{10}	8.70	0.20	0.19	5.80	7.40	168.00	17.02	277.76	0.36	2.40	0.06	5.75
11	S_{11}	8.89	0.80	0.13	6.20	6.05	118.11	15.23	252.51	0.42	2.30	0.04	5.78
12	S_{12}	8.61	0.40	0.29	2.80	7.51	165.25	22.40	267.36	0.45	3.50	0.02	5.82
13	S_{13}	8.90	0.58	0.10	6.00	6.85	113.08	15.23	262.92	0.46	2.10	0.02	5.78
14	S_{14}	8.83	0.15	0.14	4.60	6.20	55.16	37.65	251.82	0.38	1.50	0.02	5.72
15	S_{15}	8.91	0.23	0.17	4.40	10.15	130.34	13.44	300.00	0.40	3.60	0.12	5.81
16	S_{16}	9.42	0.52	0.15	4.20	8.50	125.75	17.02	226.85	0.38	2.20	0.04	5.82
17	S_{17}	8.93	0.60	0.07	4.00	6.30	55.16	20.60	218.98	0.43	3.70	0.04	5.85
18	S_{18}	9.26	0.80	0.08	5.80	6.30	74.47	38.25	246.34	0.40	1.80	0.06	5.59
19	S_{19}	8.88	0.50	0.18	3.20	11.40	165.46	33.15	260.95	0.41	2.20	0.04	5.85
20	S_{20}	8.79	0.20	0.14	5.60	7.10	110.56	30.46	250.70	0.58	3.40	0.04	5.78
21	S_{21}	8.72	0.21	0.13	3.00	7.60	113.08	20.60	254.80	0.57	3.00	0.02	5.86
22	S_{22}	8.60	0.48	0.17	5.50	5.55	150.45	13.14	254.83	0.41	3.50	0.06	5.71
23	S_{23}	8.75	0.85	0.16	5.90	9.40	135.16	17.02	248.65	0.32	4.40	0.06	5.65
24	S_{24}	9.35	0.52	0.20	3.50	7.92	151.70	22.40	241.85	0.33	3.80	0.04	5.64
25	S_{25}	8.98	0.45	0.29	2.89	11.42	168.14	17.02	310.22	0.60	4.30	0.19	6.00
26	S_{26}	9.22	0.20	0.17	4.10	11.35	125.95	20.60	261.15	0.42	3.90	0.04	5.87
27	S_{27}	8.60	0.30	0.16	5.40	9.20	123.55	30.46	266.07	0.35	4.20	0.04	5.36
28	S_{28}	8.82	0.81	0.29	5.80	8.54	108.46	27.77	259.89	0.59	4.10	0.12	5.98
29	S_{29}	8.84	0.84	0.17	4.20	8.60	115.85	42.11	260.86	0.40	1.70	0.04	5.82
30	S_{30}	9.12	0.45	0.14	3.70	6.90	100.47	27.77	251.65	0.48	4.00	0.02	5.52
31	S_{31}	8.53	0.40	0.16	3.20	8.50	124.65	32.25	256.39	0.47	2.80	0.04	5.58
32	S_{32}	8.69	0.20	0.13	3.80	8.20	90.35	30.46	251.82	0.41	4.10	0.12	5.55
33	S_{33}	8.50	0.82	0.15	4.50	8.80	95.25	27.77	232.99	0.40	3.30	0.40	5.61
34	S_{34}	8.76	0.53	0.16	4.20	11.00	135.34	36.73	226.85	0.29	3.80	0.12	5.65
35	S_{35}	8.40	0.60	0.12	3.50	7.52	151.70	41.21	218.98	0.34	1.60	0.06	5.83
36	S36	8.32	0.85	0.21	4.00	7.40	55.16	41.59	246.34	0.30	1.50	0.02	5.83

37	S_{37}	8.70	0.84	0.17	3.30	9.60	137.12	42.45	230.16	0.38	1.70	0.08	5.84
38	S_{38}	8.52	0.87	0.15	3.00	9.20	102.76	42.11	238.88	0.47	1.80	0.04	5.83
39	S_{39}	8.58	0.75	0.14	3.40	8.90	92.25	39.42	212.92	0.42	2.70	0.04	5.82
40	S_{40}	8.82	0.85	0.13	4.50	9.60	95.18	46.59	296.16	0.41	1.60	0.02	5.85
41	S_{41}	8.75	0.38	0.13	4.35	8.48	114.82	40.08	261.31	0.29	1.76	0.04	5.81
42	S_{42}	8.73	0.54	0.10	3.85	6.78	99.44	26.74	252.10	0.40	3.98	0.02	5.51
43	S_{43}	8.42	2.84	0.12	3.35	8.38	123.62	31.22	256.84	0.38	1.99	0.04	5.57
44	S_{44}	9.00	0.36	0.09	3.95	8.08	89.32	29.43	252.27	0.34	4.21	0.12	5.54
45	S_{45}	8.65	0.39	0.11	4.65	8.68	94.22	26.74	238.44	0.33	2.89	0.27	5.60
46	S_{46}	9.13	0.15	0.12	4.35	8.58	134.31	35.70	235.85	0.25	3.75	0.12	5.64
47	S_{47}	8.61	0.33	0.08	3.65	7.40	150.67	40.18	219.43	0.27	1.73	0.06	5.82
48	S_{48}	8.94	0.35	0.17	4.15	9.15	54.10	40.56	246.79	0.28	1.71	0.02	5.82
49	S_{49}	8.88	0.85	0.13	3.45	9.48	136.09	40.42	230.61	0.29	1.78	0.08	5.83
50	S_{50}	7.94	0.75	0.11	3.15	9.08	101.73	41.08	239.33	0.34	1.79	0.04	5.82
51	S_{51}	8.42	0.65	0.10	3.55	8.78	91.22	38.39	213.39	0.35	2.03	0.04	5.81
52	S_{52}	8.07	0.45	0.09	4.65	9.48	94.15	43.56	282.25	0.37	1.74	0.02	5.83
53	S_{53}	8.63	0.78	0.18	5.85	8.86	54.13	32.12	238.30	0.50	1.79	0.02	5.82
54	S_{54}	9.65	0.30	0.14	6.25	6.28	54.13	41.08	225.17	0.48	1.75	0.06	5.77
55	S_{55}	9.52	0.26	0.17	5.55	8.71	143.97	34.41	250.73	0.49	1.78	0.04	5.83
56	S_{56}	8.82	0.32	0.19	5.95	10.18	150.67	44.57	280.45	0.44	1.74	0.02	5.84
57	S_{57}	8.75	0.14	0.18	6.25	7.28	149.43	35.70	284.55	0.40	2.13	0.04	5.77
58	S_{58}	8.40	0.38	0.15	5.85	8.08	150.67	40.18	291.33	0.33	3.26	0.02	5.79
59	S_{59}	8.80	0.22	0.07	7.65	6.38	92.74	31.22	280.56	0.20	2.71	0.03	5.59
60	S_{60}	9.54	0.48	0.08	5.55	6.28	73.44	26.74	236.39	0.30	2.80	0.06	5.67
61	S_{61}	9.38	0.34	0.10	6.05	7.66	151.61	24.05	283.36	0.34	2.71	0.02	5.69
62	S_{62}	9.00	0.20	0.15	5.95	7.28	158.45	15.99	270.34	0.28	1.95	0.06	5.74
63	S_{63}	8.94	0.66	0.09	6.63	9.93	117.08	14.20	252.96	0.35	1.91	0.04	5.77
64	S_{64}	9.34	0.59	0.15	2.97	6.98	150.35	21.37	270.65	0.43	2.65	0.02	5.81
65	S_{65}	9.49	0.24	0.06	6.35	6.73	112.05	14.20	263.37	0.39	1.81	0.02	5.77
66	S_{66}	9.22	0.18	0.10	4.75	6.08	54.13	36.62	252.27	0.29	1.65	0.02	5.71
67	S_{67}	8.60	0.73	0.13	4.55	11.50	129.31	12.41	295.85	0.30	3.02	0.12	5.80
68	S_{68}	9.16	0.25	0.11	4.35	8.38	124.72	15.99	227.30	0.29	1.84	0.04	5.81
69	S_{69}	9.49	0.78	0.04	4.15	6.18	54.13	19.57	219.43	0.38	4.05	0.04	5.84
70	S_{70}	9.22	0.14	0.05	5.95	6.18	73.44	37.22	246.79	0.40	1.76	0.06	5.58
71	S_{71}	9.00	0.88	0.14	3.35	11.61	157.25	32.12	270.25	0.37	3.06	0.04	5.83
72	S_{72}	8.56	0.30	0.10	5.75	6.98	109.53	29.43	251.15	0.56	2.94	0.04	5.77
73	S_{73}	9.10	0.56	0.06	3.15	7.48	112.05	19.57	255.25	0.52	2.13	0.02	5.84
74	S_{74}	8.57	1.45	0.13	5.65	9.48	149.42	12.13	255.28	0.36	3.00	0.06	5.70
75	S_{75}	7.70	0.79	0.12	6.25	9.28	134.13	15.99	249.10	0.42	4.30	0.06	5.64
76	S_{76}	8.92	0.81	0.16	3.65	6.18	150.67	21.37	242.30	0.24	4.28	0.04	5.63
77	S_{77}	8.73	0.14	0.26	3.00	11.60	160.10	15.99	302.65	0.58	4.18	0.02	5.90
78	S_{78}	9.87	0.36	0.13	6.25	7.40	124.92	19.57	270.65	0.23	3.25	0.04	5.85
79	S_{79}	8.68	0.28	0.12	5.55	9.08	122.52	29.43	266.52	0.22	4.15	0.04	5.37
80	S_{80}	9.05	0.16	0.25	5.95	8.54	107.43	26.74	260.34	0.59	4.11	0.12	5.89
Mean		8.82	0.53	0.15	4.76	8.19	116.13	29.43	255.52	0.39	2.75	0.06	5.75
Max.		9.87	2.84	0.29	7.65	11.61	168.14	46.59	310.22	0.60	4.40	0.40	6.00
Min.		7.50	0.04	0.04	2.80	5.40	54.10	12.13	212.92	0.20	1.50	0.02	5.36

Table 2: Macronutrient status of soils of Gharsana tehsil

S. No.	Parameters	Range (kg ha^{-1})		No. of samples			Nutrient index
		Min.	Max.	Low	Medium	High	
1.	Available N	54.10	168.14	80	0	0	1(low)
2.	Available P_2O_5	12.13	46.59	36	44	0	1.55 (low)
3.	Available K_2O	212.92	310.22	0	64	16	2.2 (medium)
4.	Organic carbon(%)	0.04	0.29	80	0	0	1(low)
5.	$CaCO_3$ (%)	<5	5-10	36	44	0	Medium

Table 3: Micronutrient status (ppm) of soils of Gharsana tehsil

S. No	Micronutrient Content	Range			Critical limit	Per cent sample deficient
		Min.	Max.	Mean		
1.	Zn	0.20	0.60	0.40	0.6	100
2.	Fe	1.50	4.40	2.84	4.5	100
3.	Cu	0.02	0.40	0.06	0.2	97.5
4.	Mn	5.36	6.00	5.76	3.5	00

Conclusion

The soil fertility status of Gharsana tehsil anticipate problems in successful maintenance of irrigated agriculture under cultivation due to majority of soils were found strongly alkaline and calcareous in nature and organic carbon is very low (< 0.50%). Available nitrogen and phosphorus status of soils of Gharsana tehsil shows 100 per cent and 45 per cent deficient, respectively. The soil micronutrient status of Gharsana tehsil is also poor. In general, the zinc, iron and copper content of soils are found 100 per cent and 97.50 per cent deficient, respectively.

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