Table 7. Heterosis for stickiness of fibres

Testers / Lines	H5			H8			H12			HL34		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
Intra-*hirsutum* hybrids												
H9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-15.47*	-26.79**	0.00
H10	0.00	0.00	0.00	73.20**	0.00	71.83**	0.00	0.00	0.00	-15.47*	-26.79**	0.00
H11	0.00	0.00	0.00	54.90**	0.00	54.93**	0.00	0.00	0.00	15.47*	0.00	36.62**
H13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.41**	26.79**	71.83**
H16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.47*	-26.79**	0.00
H19	0.00	0.00	0.00	0.00	0.00	0.00	54.90**	0.00	54.93**	15.47*	-26.79**	0.00
H22	-8.38*	-15.47*	0.00	-8.38*	-15.47*	0.00	-8.38*	-15.47*	0.00	-21.54**	-26.79**	0.00

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QUALITY OF DIFFERENT SOURCES OF IRRIGATION WATER OF JAMMU REGION

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ABSTRACT

Water samples from different sources *viz.*, rivers, streams, nallahs, tube wells and hand pumps in Jammu region were collected and analysed for quality parameters to ascertain their suitability for irrigation purposes. Except some of the tubewell and hand pump water samples which showed higher values of residual sodium carbonate, most of the water sources were observed to be suitable for irrigation purposes.

KEY WORDS : Water quality, irrigation sources, Jammu

Chemical analysis of the water indicates its suitability for irrigation purposes. Rivers, nallahs and streams are the important potential sources of irrigation water in the Jammu region of Jammu and Kashmir State. Besides, tubewells and shallow dug wells also provide an alternative source of irrigation in some parts of the subtropical plains of Jammu. Some cultivated areas in the districts Jammu and Kathua which are mostly flat and possess high water table fall in this category. Farmers also use water from hand pumps, on a very small scale, for irrigating their kitchen gardens, continuous use of bad quality water (having excess of soluble salts in the form of chlorides, sulphate or even borates of sodium or even other cations) can result in salinity or alkalinity in soil which may affect crop yield and its quality. The current study was therefore, planned to ascertain the quality of different sources of irrigation water *viz.*, rivers, streams, nallahs, tubewells and shallow hand pumps in the Jammu region of Jammu and Kashmir State.

MATERIALS AND METHODS

Water samples from 10 rivers, streams and nallahs, 8 tubewells and 16 hand pumps from different places of Jammu region were collected. Sample from rivers, streams and nallahs were collected in the months of November and December when there was normal flow and from tubewell and hand pumps in the month of May and June of the same year. The samples were analysed for different cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+}) and anions (Cl^{-}, $SO4^{-}$, $CO3^{--}$, $HCO3^{-}$) by routine methods. Besides, pH and electrical conductivity were also estimated.

RESULTS AND DISCUSSION

Category A: Rivers, streams and nallahs

The pH of water samples falling in this category ranged from 7.20 to 8.10 with a mean value of 7.59 (Table 1) indicating their alkaline nature. The electricals conductivity values varied from 162 to 310 with an average value of 240 micromhos/cm. The highest value of 310

Table 1. Chemical composition of different sources of irrigation water in Jammu Region (J & K)

Location	Cations (me/l)							Anions (me/l)			
	pH	EC (micro-mhos/cm)	CCa+Mg	Na	K	SAR	SSP	CO_3+HCO_3	Cl	SO_4	RSC (me/l)
Category A: Rivers, streams and nallahs											
Jammu Tawi (Jammu)	(7.20)	180	(3.00)	0.10	0.40	0.37	2.85	3.40	0.50	0.70	0.40
Chenav river (Akhnoor)	7.40	270	2.25	0.17	0.31	0.16	6.22	3.10	0.50	0.68	0.85
Rajouri nallah (Rajouri)	7.30	(162)	2.05	0.10	0.25	0.10	4.16	2.13	0.26	(0.60)	(0.08)
Poonch Nallah (Poonch)	7.40	260	1.87	0.15	0.25	0.10	6.60	1.96	(0.21)	1.05	0.09
Surankote nallah	7.90	310	2.56	0.20	0.27	0.18	6.60	3.00	0.77	1.49	0.44
Mandi nallah (Mandi)	7.90	178	1.60	0.09	0.30	0.10	4.34	1.90	0.73	0.98	0.30
Ujh nallah	7.70	(310)	2.70	0.20	0.35	0.17	6.15	2.96	0.40	0.71	0.26
Devika nallah (Udhampur)	(8.10)	260	1.60	(0.85)	(0.95)	(0.95)	(25.0)	2.30	(0.90)	(1.70)	(1.20)
Ravi river (Lakhanpur)	7.70	260	2.45	(0.08)	0.45	(0.08)	(2.68)	(3.40)	0.40	1.25	0.95
Neeru nallah (Doda)	7.35	210	0.96	(0.08)	0.25	0.11	6.20	(1.16)	0.36	1.16	0.20
Range	7.20	162	0.96	0.08	0.25	0.08	2.68	1.16	0.21-0.90	0.60	0.08-1.20
	8.10	310	3.00	0.85	0.95	0.95	25.0	3.40		1.71	
Mean	7.59	240	2.10	0.20	0.37	0.23	7.08	2.53	0.49	1.03	0.47
Category B: Tube wells											
R.S. Pura	8.10	590	5.25	1.05	1.45	0.64	13.54	6.10	0.50	1.25	0.85
Arnia	8.46	613	3.71	(2.61)	(2.90)	(1.90)	28.03	5.81	(0.87)	(2.10)	(2.10)
Agrachak	8.61	640	5.35	1.46	2.10	0.55	16.38	6.00	0.53	1.20	0.65
Bedial	8.60	646	5.42	0.84	1.25	0.51	11.18	6.75	0.71	0.90	1.33
Kadial	8.42	600	(5.54)	1.00	1.90	0.60	11.84	(7.35)	0.51	1.10	1.81
Satrian	(8.64)	(730)	5.25	1.12	1.90	0.69	13.54	7.27	0.62	0.92	2.02
Kathua	7.40	220	(1.80)	0.30	0.60	0.31	11.11	2.60	0.40	0.70	0.80
Hiranagar	(7.20)	(210)	(1.80)	(0.20)	(0.50)	(0.29)	10.85	(2.30)	(0.30)	(0.52)	0.60
Range	7.60	210	1.80	0.28	0.50	0.29	10.85	2.30	0.30	0.60	0.60
	8.64	730	5.54	2.61	2.19	1.91	29.03	7.35	0.87	2.10	2.10
Mean	8.17	531	4.26	1.08	1.59	0.68	14.42	5.52	0.55	1.08	1.28
Category C: Hand pumps											
R.S. Pura (new)	8.10	690	5.00	0.60	1.70	0.38	8.22	5.20	8.43	1.10	0.20
R.S. Pura (old)	7.70	550	4.40	0.32	1.10	(0.21)	5.50	4.80	0.50	1.15	0.40
Deblehar	7.50	376	5.60	0.90	1.70	0.59	12.50	5.90	0.65	1.56	0.30
Chak B	7.50	520	6.30	0.69	1.20	0.39	8.42	6.82	0.55	0.90	0.52
Rangpur	(8.40)	630	4.80	0.65	1.20	0.42	9.77	5.20	0.45	0.70	0.40
Bishnah	8.30	(800)	(8.90)	1.62	1.15	0.76	13.88	(9.71)	2.95	2.10	0.81
Deoli (a)	7.80	670	6.70	1.55	1.60	0.85	15.73	7.95	2.15	1.90	1.25
Deoli (b)	7.70	690	6.40	1.60	1.22	0.81	16.12	7.70	2.05	2.40	(1.30)
Majalta (a)	7.80	280	5.30	0.96	1.38	0.59	12.56	5.40	0.35	1.00	(0.10)
Majalta (b)	7.70	280	5.10	0.55	1.10	0.34	8.15	5.20	0.27	1.25	(0.10)
Hiranagar (a)	7.40	240	5.40	0.45	0.90	0.27	6.67	5.70	0.25	0.60	0.0
Hiranagar (b)	7.30	170	4.50	0.39	0.60	0.26	7.10	4.80	0.25	0.66	0.30
Goomanansa	7.45	350	5.60	0.65	1.10	0.39	8.84	6.00	0.15	0.40	0.0
Marh	8.10	680	4.65	0.60	0.90	0.39	9.70	5.00	0.31	0.90	0.35
Kathua	(725)	(156)	5.60	0.90	1.35	0.54	11.46	6.80	(0.20)	0.72	0.24
Ramgarh	8.15	716	(3.50)	1.48	1.60	(1.06)	24.76	(4.54)	0.40	0.85	1.04
Range	7.25	156	3.58	0.32	0.60	0.21	5.50	4.54	0.20	0.60	0.10-1.30
	8.40	800	8.90	1.60	1.92	1.06	24.76	9.71	0.95	0.40	
Mean	7.77	4.87	5.48	0.86	1.23	0.52	11.21	5.98	0.74	1.13	0.50

Note : The values in parenthesis indicate the lowest and the highest value of the parameter

micromhos/cm was observed in Ujh sample. All the water samples except Jammu Tawi and nallahs of Rajouri, Mandi (Poonch) and Doda (Neeru) fell in C_2S_1 (medium salinity low alkalinity) class according to Richard (1954). The very low sodium absorption ratio (SAR) values (below 3.00), soluble sodium percentage (SSP) less than 60 and residual sodium carbonate (RSC) less than 1.25 me/L do not show any sort of sodium or salt hazard. The results are in line with those of Charak *et al.*, (1985). The contents of potassium and sodium, in general, were low in all the samples. Sulphate concentration which ranged from 0.60 to 1.71 me/L generally exceeded the chloride concentration (0.21-0.90) in all the samples. Water of all these sources can safely be used for irrigation purposes.

Category B : Tubewells

The pH and electrical conducivity (EC) values (Table 1) in different tubewell water samples ranged from 7.20 to 8.64 and 210 to 730 micromhos/cm. The water sample of Satrain (R.S. Pura Tehsil) gave the highest values both of pH (8.49) and EC (730 micromhos/cm) whereas the lowest values in both these parameters were observed in Kathua sample. The EC values were observed to be consistent with pH values in most of the samples. Similar results were reported for ground waters of Chambal Command Area. The EC values in most of tubewell waters were higher than 250 micromhos/cm except the water samples of Kathua and Hiranagar which indicates moderate salinity.

The SAR, SSP and RSC values varied from 0.29 to 1.91 (mean 0.68), 10.85 to 28.03 (mean 14.42) and 0.60 to 2.10 m/l (mean 1.28 me/l) respectively. No sodium hazard was observed in any tubewell water sample as the SAR values were lower than the critical limit of 3.0. The results coroborate the finding of Charak and Sharma (1985).

The water samples of Arnia recorded highest value of sodium adsorption ratio. This may be due to higher value of soluble sodium percentage (SSP) compared to combined values of calcium and magnesium cations. The concentrations of combined calcium and magnesium also greatly exceeded the sulphate concentration. In the presence of low sulphate concentration the Ca and Mg are not activated and thus the water can be used for irrigational purposes by applying simple management practices. The concentration of chlorides was less than sulphate ion and magnesium was higher than calcium in most of the water samples. According to Richard (1954) all the tubewell waters fall in the C_2S_1 (moderate salinity low sodium) class. The water of Arnia, Badia, Kadial and Satrain tubewell in R.S. Pura tehsil of Jammu District was observed to be unsuitable for irrigation due to high content of residual sodium carbonate.

Category C : Hand pumps

The pH of water samples (Table 1) collected from some of the hand pumps varied from, 7.25 in Kathua to as high as 8.40 in Rangpur (R.S. Pura) indicating alkaline nature. The electrical conductivity values ranged from 156 to 800 micromhos/cm, the lowest in Kathua and the highest in Bishnah. All the samples fall in the medium salinity low sodium (C_2S_1) category except those of Kathua and Hiranagar having EC values less than 250 micromhos/cm (Richard, 1954).

The concentration of magnesium ions was observed to be higher than that of calcium while those of sulphates ions was more than chloride ions indicating their safer nature. The SAR, SSP and RSC values of the water sample in this category ranged from 0.21 to 1.06 (0.52, 5.50 to 24.76 (11.21) and 0.10 to 1.30 (0.50 me/1) respectively. No sodium hazard was observed in most of these samples. The samples of Deoli village of Bishnah tehsil of Jammu district having RSC value greater than 1.25 me/l, however, should be used cautiously as their longer use may render the soil less productive.

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