



Short communication

## Varietal assessment, heritability estimates and correlation studies in apple cultivars of South Kashmir

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### ABSTRACT

A study was conducted to assess agronomic performance and heritability estimates among different cultivars of apple in district Pulwama of Kashmir valley. Twenty cultivars aged 20 to 22 years were selected for the present study. Data were collected on physical and chemical characters of fruit and yield of the tree. Results revealed that 'Red Delicious' (315.43kg) and Ambri (310.40kg) Difenonazole highest yield among all the cultivars. Red Delicious apple recorded maximum fruit weight (182.63g), maximum TSS (16.35%) and total sugars (12.11%) with least acidity (0.07%) was recorded in Ambri apples. All the characters studied showed high heritability estimates except for cropping efficiency (61.06%) which scored least heritability. Length (0.843) and breadth (0.854) of fruit positively and significantly correlated with weight of the fruit. Acidity was negatively correlated with all other biochemical characters.

**Key words:** Heritability, correlation, varietal assessment, apples, cropping efficiency

Apple is an important fruit crop grown in the temperate region of India. It accounts for 43.30 per cent of total area under fruits and 80.18 per cent of total fruit production in Jammu and Kashmir. It is major cash crop and is the backbone of economy in the state. It is grown in almost all the districts of Kashmir valley, in an area of 1.27 hectares with annual production of 1354.6 thousand metric tons (Anonymous, 2009). Apple productivity in the state has been on the increase since the past two decades because, farmers have adopted recent technologies. Although farmers grow only a few varieties, there is a tremendous diversity in apple germplasm in the departmental and farmers' orchards that remains to be exploited. Although a lot of work has been done on quality and yield parameters a few, existing varieties dominating Kashmir valley, on quality and yield parameters varietal assessment in other varieties has not been conducted so far. To assess these varieties of apple on the basis of physico-chemical characteristics and yield parameters, the present study was undertaken in local orchards of Pulwama district in South Kashmir.

Investigations were carried out during 2008-09 in farmers' orchards of Shopian area of the district. The following 20 cultivars were selected, viz., Stark's Earliest,

Tropical Beauty, Orange Sweet, Galia Beauty, King David, Black Ben Davis, Parlins Beauty, Early Shanburry, Tamma, Rome Beauty, Benoni, Lord Lambourne, Laxton's Superb, Cox's Orange Pippin, Red Gold, American Apirouge, Starkrimson, Red Delicious, Sunheri and Ambri. The experiment was laid out in Completely Randomized Block Design (CRBD) with three replications. Plants raised on seedling rootstock with a spacing of 5 x 5m aged 20 to 22 years were selected for the study. Four representative branches from each treatment in each replication were selected randomly in the four directions of tree canopy to ensure precision. Data recorded for yield efficiency was calculated as per Westwood (1993) and expressed in kg/cm<sup>2</sup>. Other yield and fruit characters like yield per plant (kg), fruit weight (g), fruit length (mm), fruit breadth (mm) and biochemical analysis, viz., TSS (°Brix) were recorded. Acidity (%), reducing sugars (%), total sugars (%) and TSS/acid ratio were estimated according to Ranganna (1979). Data thus obtained were analyzed following standard procedures (Panse and Sukhatme, 1995). Coefficient of variability was calculated as per Burton and DeVane (1953) while heritability, genetic advance and genetic gain were calculated as per Johnson *et al* (1955).

Data of mean values pertaining to various yield and fruiting characters are presented in Table 1. Mean values for yield efficiency ranged between 0.08 kg/cm<sup>2</sup> (Orange Sweet) to 0.37 kg/cm<sup>2</sup> (Sunheri). Maximum fruit yield (315.43kg) per plant could be harvested from 'Red Delicious' followed by 'Ambri' (310.40kg/plant), while minimum yield was recorded in 'Orange Sweet' (50.43 kg/plant). Cultivar 'Red Delicious' also had maximum fruit weight (182.63g), which differed statistically from all other cultivars, whereas, lowest fruit weight (46.60g) registered in cv. 'Stark's Earliest'. While working with different cultivars, Farooqui *et al* (1986) also recorded maximum fruit weight in Red Delicious apple. Maximum fruit length (73.57mm) and fruit breadth (77.13mm) was seen in fruits of 'Red Delicious' (which were statistically at par with all other cultivars) However, minimum fruit length (39.35mm) and fruit breadth (47.66mm) was recorded in 'Stark's Earliest'. In agreement with present investigations, Diwakar *et al* (1981) and Singh *et al* (2005) observed similar findings with respect to fruit weight, fruit length and fruit breadth in different cultivar of apple. Titrable acidity ranged from 0.14% (Ambri) to 0.78% (Orange Sweet). Cultivar 'Ambri', with highest total soluble solids-TSS (16.35%) and TSS/acid ratio (116.78%) significantly differed from other cultivars. Lowest TSS (10.21%) and TSS/acid ratio (13.17%) was recorded in

'Orange Sweet'. Maximum reducing sugars (7.44%) registered in 'Starkrimson', followed by 'Rome Beauty' (7.40%) whereas, minimum was recorded in 'Red Gold' (4.44%). Cultivar 'Ambri' recorded highest total sugars (12.11%) which was statistically superior to all other cultivars. Lowest total sugars were recorded in 'Stark's Earliest' (6.73%). Kumar and Verma (2001) also reported similar values for various biochemical characters in cv. 'Starkrimson'.

Data on variability parameters are presented in Table 2. In the present study, phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the traits studied. Phenotypic coefficient of variation (99.90%) and genotypic coefficient of variation (96.50%) were highest for TSS/acid ratio. Lowest values were observed for fruit breadth at 11.97% (phenotypic coefficients of variation) and 11.37% (genotypic coefficient of variation), respectively. Among heritability estimates values, maximum estimates were observed for fruit weight (99.50%) closely followed by yield per plant (99.14%) and total sugars (98.02%) while, lowest values were recorded for yield efficiency (61.06%). Genetic gain (genetic advance as per cent of mean) was found to be maximum for TSS/acid ratio (192.01%) followed by acidity (118.85%). Minimum value of genetic gain (22.24%) was recorded for fruit breadth.

**Table 1. Performance of various apple cultivars on yield and fruiting characters in Pulwama district of South Kashmir**

Variety	Yield efficiency kg/cm <sup>2</sup>	Yield/plant (kg)	Fruit weight (g)	Fruit length (mm)	Fruit breadth (mm)	Acidity (%)	TSS (%)	TSS/acid ratio	Reducing sugars (%)	Total sugars (%)
Stark Earliest	0.35	235.03	46.60	39.35	47.66	0.25	10.40	41.60	5.16	6.73
Tropical Beauty	0.27	213.90	53.33	42.59	50.57	0.35	13.15	38.55	6.75	10.36
Orange Sweet	0.08	50.43	90.15	57.39	64.92	0.78	10.21	13.17	4.76	7.55
Galia Beauty	0.24	250.50	60.32	41.26	55.21	0.70	12.61	18.08	5.77	8.21
King David	0.16	75.03	73.13	51.33	57.47	0.51	13.60	26.96	6.27	9.31
Black Ben Davis	0.21	135.57	53.30	46.43	56.24	0.31	13.69	44.81	6.28	9.63
Parlins Beauty	0.31	200.83	72.07	49.68	57.19	0.64	11.87	18.59	6.85	9.15
Early Shanburry	0.24	265.70	90.37	57.51	64.43	0.76	10.65	14.06	6.27	8.41
Tamma	0.21	150.33	56.53	46.43	53.44	0.49	13.37	27.52	6.88	9.59
Rome Beauty	0.15	85.17	56.57	43.34	54.32	0.29	13.25	45.69	7.40	10.05
Benoni	0.22	200.47	60.17	48.33	54.22	0.36	11.22	31.52	5.36	7.42
Lord Lambourne	0.14	120.57	86.60	59.19	65.51	0.35	12.25	35.34	5.50	8.08
Laxton's Superb	0.24	130.57	73.53	45.28	57.40	0.33	12.40	38.31	6.17	8.66
Cox's Orange Pippin	0.18	190.40	91.80	51.84	62.24	0.37	11.41	31.26	6.37	7.66
Red Gold	0.33	190.47	66.27	46.28	56.79	0.32	11.65	37.94	4.44	7.79
American Apirouge	0.30	230.10	68.38	44.40	55.30	0.34	13.52	40.07	6.60	9.57
Starkrimson	0.33	125.47	87.96	56.56	62.67	0.39	14.10	36.15	7.44	11.34
Red Delicious	0.35	315.43	182.63	73.57	77.13	0.20	13.67	71.25	5.27	9.15
Sunheri	0.37	95.80	60.30	52.97	52.73	0.32	15.27	47.72	7.18	11.24
Ambri	0.36	310.40	70.30	59.02	66.30	0.14	16.35	116.78	7.15	12.11
CD ( <i>P</i> =0.05)	0.10	11.74	3.39	3.16	3.63	0.07	0.42	25.78	0.30	0.33

## Variability in apple cultivars of South Kashmir

**Table 2. Estimates of heritability, genetic advance and genetic gain in various apple cultivars**

Character	Mean	CV	Coefficient of variance		Heritability	Genetic advance	Genetic gain
			Phenotypic	Genotypic			
Yield efficiency	0.25	24.25	38.87	30.37	61.06	0.12	48.89
Yield/ plant	178.61	3.98	42.93	42.75	99.14	156.60	87.68
Fruit weight	75.02	2.73	38.59	38.50	99.50	59.34	79.10
Fruit length	50.64	3.77	16.41	15.97	94.72	16.22	32.03
Fruit breadth	58.59	3.75	11.97	11.37	90.20	13.03	22.24
Acidity	0.37	12.04	60.10	58.89	95.99	0.44	118.85
TSS	12.73	1.99	12.58	12.42	97.49	3.22	25.26
TSS/acid ratio	60.31	25.86	99.90	96.50	93.30	115.79	192.01
Reducing sugar	6.19	2.94	14.42	14.12	95.85	1.76	28.47
Total sugar	9.10	2.23	15.86	15.70	98.02	2.91	32.03

**Table 3. Correlation of genotypic (above diagonal) and phenotypic (below diagonal) level among various characters in apple cultivars**

Character	Yield efficiency	Yield/ plant	Fruit weight	Fruit length	Fruit breadth	Acidity	TSS	TSS/ acid ratio	Reducing sugars	Total sugars
Yield efficiency	1	0.654**	0.100	0.065	- 0.039	- 0.562**	0.425**	0.471**	0.160	0.413**
Yield/ plant	0.505**		0.303*	0.179	0.260*	- 0.071	0.062	0.131	- 0.106	- 0.011
Fruit weight	0.065	0.304*		0.870**	0.902**	0.003	0.013	- 0.003	- 0.025	- 0.043
Fruit length	0.073	0.177	0.843**		0.954**	- 0.043	0.203	0.221	- 0.101	0.191
Fruit breadth	- 0.058	0.248	0.854**	0.878**		0.041	0.108	0.175	- 0.169	0.071
Acidity	- 0.373**	- 0.064	0.001	- 0.042	0.048		0.570**	- 0.764**	- 0.315*	- 0.470**
TSS	0.372**	0.066	0.012	0.192	0.095	- 0.537**		0.682**	0.651**	0.913**
TSS/acid ratio	0.326*	0.127	- 0.001	0.191	0.158	- 0.741**	0.643**		0.520**	0.710**
Reducing sugar	0.164	- 0.096	- 0.238	- 0.077	- 0.175	- 0.299*	0.639**	0.490**		0.813**
Total sugar	0.323*	- 0.005	- 0.040	0.183	0.085	- 0.448**	0.898**	0.676**	0.796**	1

Significant at \*\*0.01 % and 0.05 %

High heritability estimates, along with high genetic gain, were also noticed by Barua (2000) and Sharma *et al* (2005) in different cultivars of apple for these characters.

Yield efficiency showed a positive and highly significant correlation with yield per plant (0.654), TSS (0.425), TSS/acid ratio (0.471) and total sugars (0.413), but a negative correlation with acidity (-0.562). Fruit weight was positively, and highly significantly, correlated with fruit length (0.870) and fruit breadth (0.902). Acidity was positively, and highly significantly, correlated with TSS (0.570). However, it was negatively, but highly significantly, correlated to TSS/acid ratio (-0.764), reducing sugars (-0.315) and total sugars (-0.470). Total soluble solids showed positive and highly significant correlation with TSS/acid ratio (0.682), reducing sugars (0.651) and total sugars (0.913). TSS/acid ratio was positively, and highly significantly, correlated with reducing sugars (0.520) and total sugars (0.710). Similar trend was noted with regard to reducing and total sugars. Significant correlation in fruit characters suggests scope or direct and indirect, effective selection for further improvement.

It is concluded from the present study that most of the area in the district is covered by 'Red Delicious' and 'Ambri' (a local strain) apples, which give high yield and quality fruits.

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(MS Received 10 January 2011, Revised 5 January 2012)