PERFORMANCE OF POMEGRANATE (Punica granatum L.) CULTIVARS FOR GROWTH, YIELD AND PHYSICO-CHEMICAL TRAITS UNDER KAREWA EDAPHOLOGICAL CONDITIONS IN TEMPERATE CLIMATE OF KASHMIR VALLEY

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ABSTRACT

Eight varieties of pomegranate were evaluated under Karewa condition of Kashmir valley at Central Institute of Temperate Horticulture (CITH), Srinagar, for five years i.e. from 2006-07 to 2009-10, The Cultivar ‘Bedana’ had maximum plant spread followed by ‘Chawla’, ‘Jyoti’ and, ‘Dholka’. The plant height in ‘Chawla’ was significantly more compared to other cultivars. The maximum number of fruit per tree, fruit set, fruit size, fruit length, fruit calyx diameter, fruit weight, fruit volume, yield/tree, TSS, ascorbic acid, acidity, total chlorophyll content and minimum aphid attack recorded in ‘Dholka’. The cultivar ‘Kandhari’ was found superior in reducing sugar, and total sugar. However, cultivar ‘Jyoti’ was better in bloom period, number of Seed + Aril, minimum fruit cracking, anar butterfly attack. Fruit L/D ratio was found highest in ‘Chawla’, and maturity index highest in cultivar ‘Mridula’. The local variety of region ‘Kashmir Local’ was also found better in juice pH 46 and shelf life at ambient condition 65.26 days.

Key Words: Pomegranate, performance, Karewa condition, vegetative growth, fruit morphology physico-chemical properties and yield.

Pomegranate has been traditionally cultivated since ancient times under diverse agro-climatic conditions (Evreinoff 1949). The production and consumption of pomegranate fruits around the whole world is increasing rapidly. The fact that pomegranate fruit has a number of industrial usage, like fruit juice, conserve, vinegar, citric acid and medicine, lead to its gaining popularity in the world markets (Cemeroglu, 1977, Dokuzoguz and Mendilcioglu, 1978 and Aviram and Dornfeld, 2001). The calorific value of fruit is 65 and juice is easily digestible which contains about 15 per cent invert sugar. Fruit is also a rich source of sodium (3 mg), riboflavin

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(0.012-0.03 mg), thiamin (0.003 mg), niacin (0.180-0.3 mg), vitamin-C (4-4.2 mg), calcium (3-12 mg) and phosphorous (8-37 mg) per 100 gm of edible portion. As a cultivated crop the pomegranate is grown in many states of India like Maharashtra, Gujarat, Rajasthan, Uttar Pradesh, Haryana, Andhra Pradesh, Karnataka and Tamil Nadu and to a limited extent in Jammu and Kashmir, Himachal and Uttarakhand. In India pomegranate is being cultivated in an area of 0.12 million ha, 0.85 million t production with productivity of 7.0 t/ha (NHB, 2008), mostly in subtropical and tropical regions. In sub-tropical and temperate regions of J&K, H.P. and Uttarakhand the area is very small due to less importance given to this non-traditional crop.

As the crop possess drought hardiness, offers immense potential to grow under marginal lands. As a result it is gaining popularity among farmers all over the country particularly in rain-fed area. Similarly a large area is also available in temperate climate which offers the ideal climatic conditions for commercial cultivation of high quality pomegranate. As it is evident that world best quality pomegranates are being produced from temperate climate of Afghanistan, which are being mostly exported and earning significant amount of foreign exchange. It has vast scope of growing in marginal areas like unfertile rainfed Karewa edaphological situations. Since all the cultivars of pomegranate were not performing equally well under temperate ecosystem with respect to yield and quality attributes but due to extremes of low temperature. Keeping in view the present investigation was carried out to assess the performance of different varieties and to select the suitable varieties for commercial cultivation under temperate ecosystem.

MATERIALS AND METHODS

A study was undertaken from during 2006 and 2010 to evaluate the performance of commercial varieties under temperate ecosystem at the research farm of Central Institute of Temperate Horticulture (CITH), Srinagar. The varieties viz., ‘Mridula’, ‘Chawla’, ‘Dholka’, ‘Bedana’, ‘Kandhari’, ‘Jyoti’, ‘Kashmir Local’ and ‘G-137’ periodically observed. Planting was done at the distance of 2.5 x 2.5 m during 2001 and uniform cultural practices were provided for all cultivates. The experimental farm is situated at latitude of 34°05 N and longitude of 74°50 E at an altitude of 1640 m above the sea level. The weather parameters recorded during the growing season were viz., mean maximum temperature 19.63 °C, mean minimum 6.52 °C, rainfall 60.72 mm, relative humidity 58.35 % and evaporation 2.45 m. The soils of the experimental farm have soil pH 6.81 and electrical conductivity 0.36 dSm-1. The observations were recorded on vegetative growth (plant spread, plant height, stem girth, duration of flower, no. of fruits/plant, fruit set %, chlorophyll %), fruit characteristics (fruit weight, fruit diameter, fruit length, fruit calyx length, diameter, fruit L/D ratio, fresh fruit firmness, rind thickness, seed hardness, aril color, acidity, ascorbic acid, reducing sugar, total sugar, juice content, maturity index (MI), TSS/Acid ratio and yield per tree. Total chlorophyll content measured by CL-01 chlorophyll content meter. Twenty fruits of each cultivar were individually analyzed for physical parameters. Fruits were weighted in the air on a Sartorius balance of accuracy of 0.001 g. Fruit volume was calculated by a liquid displacement method. The length and diameter of the fruit and calyx were measured with a Mitutoyo digital vernier caliper. The measurement of fruit length was made on the polar axis, i.e. between the apex and the end of stem. The maximum width of the fruit, as measured in the direction perpendicular to the polar axis, is defined as the diameter. After measuring the whole fruit size, the arils were manually separated from the fruits, and total arils and peel per fruit were measured as above. The measurements of the peel thickness were made using the Mitutoyo digital vernier calliper. Then the juices were analyzed for major chemical composition. The titrable acidity (TA) was determined by titration to pH 8.1 with 0.1M NaOH solution and expressed as g of citric acid per 100 g of juice (AOAC, 1984). The pH measurements were performed using a digital pH meter (Delux 101) at 22 °C. The total soluble solids (TSS) were determined with Atago digital refractometer calibrated using distilled water. Results were reported as °Brix at 22 °C. The total sugars were estimated according to the method described by Ranganna (2001).
Results were expressed as g per 100 g of juice. Ascorbic acid was determined by employing the method described by Ruck (1963). Results were expressed as mg per 100 g of juice. Fruit firmness measured using HP qualitest digital firmness tester. The data (average of 5 years) was statistically analyzed using RBD by Online Statistical Analysis Package (OPSTAT, Computer Section, CCS Haryana Agricultural University, Hisar).

RESULTS AND DISCUSSION

The pertaining to vegetative growth and fruit characters showed a significant difference between varieties (Table 1). Cultivar ‘Bedana’ had maximum plant spread 128.64 mm followed by ‘Chawla’ 127.23 mm, ‘Jyoti’ 126.35 mm and ‘Dholka’ 124.66 mm. The plant height 160.82 mm recorded in ‘Chawla’ was significantly more compared to other varieties; it is obvious from the data that, ‘Bedana’, ‘Chawla’, ‘Jyoti’ cultivars were more spreading type compared to other cultivars. Stem girth varied from 42.24 mm to 60.60 mm. The maximum stem girth recorded in ‘Dholka’ and lowest in ‘Kashmir Local’. These findings are in general agreement with earlier findings of Mir et al., (2007). Regarding flowering and fruit set duration of flowering (days) was longest in ‘Jyoti’ (101.26), ‘G-137’ (100.30) followed by ‘Dholka’ (98.16). The highest fruit set percentage recorded in ‘Dholka’ (60.34), ‘Bedana’ (59.56), and ‘Kandhari’ (43.07) as compared to ‘Kashmir Local’ (27.58). The total number of fruits per tree ranged between 15.84-34.08 and maximum recorded in ‘Dholka’, while lowest in ‘Mridula’ variety. There were significant differences in average fruit diameter and weight of fruits over ‘Kashmir Local’ (Table 1). Cultivar Dholka recorded maximum fruit diameter 81.10 mm followed by ‘Bedana’ 77.03 mm, and ‘Kandahari’ 76.66 mm. The fruit length ranged from 61.16 mm in ‘Chawla’ to 79.13 mm in ‘Dholka’. Similarly, fruit L/D ratio was varied from 1.133 in ‘Chawla’ to 1.003 in ‘Kashmir Local’. The minor deviation in size (diameter, length and volume) with respect to fruit weight may be due to variation in fruit form as sometimes they are obscurely ridged as observed by Nath and Randhawa (1959).
length was recorded maximum in ‘Dholka’ followed by ‘Bedana’ and ‘Kandhari’ while fruit calyx diameter ranged from minimum 12.52 mm in ‘Kashmir Local’ to maximum 19.23 mm in ‘Dholka’. Valero and Ruiz-Altisent (2000) have reported this knowledge is particularly relevant in the design or selection of appropriate packaging for fruit handling and storage. As regard to average fruit weight of eight pomegranate cultivars under studying, data indicated non-significant differences among cultivars (‘Dholka’, ‘Kandhari’, ‘Bedana’, ‘Chawla’, ‘Mridula’, ‘G-137’, and ‘Jyoti’) but significant difference from ‘Kashmir Local’. The highest fruit weight was recorded in ‘Dholka’ (252.17 g) followed by ‘Kandhari’ (245.61 g), ‘Bedana’ (242.08) as compared to ‘Kashmir Local’ (130.40 g). Similar results were also reported by Lal et al., (2002). The variation in fruit weight was because of genetic behavior of varieties. The fruit volume also shown same trend as fruit weight and ranged between 49.16 ml and 79.64 ml. The maximum volume was recorded in ‘Dholka’ followed by ‘Kandhari’ and ‘Bedana’. Thus, it is revealed that there is a close relation between fruit weight and fruit volume. Fruit firmness index was found non-significant among all the varieties and its value ranged from 27.70 to 49.16. The cultivars ‘Chawla’, ‘Kandhari’ and ‘Kashmir Local’ varieties seed found harder than ‘Mridula’, ‘Dholka’, ‘Jyoti’, ‘Bedana’ and ‘G-137’. Color of aril also differed according to cultivars. In ‘Chawla’ and ‘Mridula’ aril was red color while ‘Dholka’, ‘Bedana’, ‘Kandhari’, ‘Jyoti’, ‘G-137’, ‘Kashmir Local’ it was pink to pinkish red.

The highest mean fruit yield/plant was recorded in ‘Dholka’ (6.54 kg) followed by ‘Bedana’ (6.06 kg), ‘Kandhari’ (5.48 kg) as compared to ‘Kashmir Local’ (3.26 kg). Fruit physical characteristics like rind weight differed significantly among cultivars. The maximum rind weight recorded in ‘G-137’ followed by ‘Kandhari’ and ‘Local Kashmiri’. Rind thickness was also varies among all the cultivars from 1.27 mm to 4.46 mm. These values were little higher than values reported by Sarkhosh et al. (2006). Number of Seed + Aril was recorded maximum in ‘Jyoti’ (639.133) followed by ‘G-137’ (631.33) and ‘Bedana’ (616.33), while weight of Seed
Arl of fruit ranged from 144.74 g to 210.53 g in selected cultivars. The juice percentage was significantly higher in ‘G-137’, ‘Bedana’, ‘Dholka’ and ‘Kandhari’ as compared to ‘Kashmir Local’. Siddappa (1943) also reported that cultivars differ in their juice content due to different genetic constitution. The seed residue in juice varied from 18.06 g to 38.71 g. Fruit cracking was recorded minimum (33.76 %) in ‘Jyoti’ and maximum (49.11 %) in ‘Kashmir Local’. That may be due to less rind thickness of ‘Kashmir Local’ and also may be due to sudden changes in climate at the time of maturity as well as variation in soil moisture and tolerance of cultivars to cracking. This is accordance with the findings of Banker and Prasad (1992).

Table 3: Fruit quality and storage characteristics of the eight pomegranate genotypes grown under Kerwa condition of Kashmir

<table>
<thead>
<tr>
<th>Varieties</th>
<th>TSS (°Brix)</th>
<th>Fruity %</th>
<th>Juice %</th>
<th>pH</th>
<th>Chlorophyll content (%)</th>
<th>Total Maturity index (TSS/TABA)</th>
<th>Sugar (%)</th>
<th>Ascorbic Acid (mg/100g)</th>
<th>Reducing Sugar (%)</th>
<th>Total Sugar (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chawla</td>
<td>13.13</td>
<td>6.037</td>
<td>0.454</td>
<td>8.457</td>
<td>10.413</td>
<td></td>
<td>40.33</td>
<td>10.413</td>
<td>0.041</td>
<td>6.34</td>
</tr>
<tr>
<td>Mirada</td>
<td>14.067</td>
<td>6.120</td>
<td>0.356</td>
<td>8.257</td>
<td>10.227</td>
<td></td>
<td>40.33</td>
<td>8.257</td>
<td>0.051</td>
<td>5.43</td>
</tr>
<tr>
<td>Jyoti</td>
<td>14.557</td>
<td>6.171</td>
<td>0.441</td>
<td>8.797</td>
<td>12.247</td>
<td></td>
<td>40.33</td>
<td>8.797</td>
<td>0.056</td>
<td>5.53</td>
</tr>
<tr>
<td>G-137</td>
<td>13.953</td>
<td>6.140</td>
<td>0.480</td>
<td>8.417</td>
<td>11.533</td>
<td></td>
<td>40.33</td>
<td>8.417</td>
<td>0.054</td>
<td>5.53</td>
</tr>
<tr>
<td>Dholka</td>
<td>14.560</td>
<td>6.340</td>
<td>0.332</td>
<td>9.833</td>
<td>12.753</td>
<td></td>
<td>40.33</td>
<td>9.833</td>
<td>0.064</td>
<td>6.34</td>
</tr>
<tr>
<td>Bedana</td>
<td>13.833</td>
<td>6.457</td>
<td>0.064</td>
<td>7.127</td>
<td>12.517</td>
<td></td>
<td>40.33</td>
<td>7.127</td>
<td>0.073</td>
<td>6.34</td>
</tr>
<tr>
<td>Kandhari</td>
<td>14.117</td>
<td>6.324</td>
<td>0.524</td>
<td>7.307</td>
<td>12.507</td>
<td></td>
<td>40.33</td>
<td>7.307</td>
<td>0.073</td>
<td>6.34</td>
</tr>
<tr>
<td>Kashmiri</td>
<td>13.660</td>
<td>0.040</td>
<td>0.440</td>
<td>6.140</td>
<td>10.007</td>
<td></td>
<td>40.33</td>
<td>6.140</td>
<td>0.051</td>
<td>5.43</td>
</tr>
<tr>
<td>CV</td>
<td></td>
<td>1.77</td>
<td>0.463</td>
<td>0.040</td>
<td>0.040</td>
<td></td>
<td>0.040</td>
<td>0.040</td>
<td>0.040</td>
<td>0.040</td>
</tr>
</tbody>
</table>

The TSS in juice of different varieties varied from 13.13 °Brix in ‘Chawla’ to 14.56 °Brix in ‘Dholka’. However, inter-varietal differences were statically significant (Table 3). This results were lower than values observed (16–19 °Brix) by Poyrazoglu et al., (2002), while present results were in agreement with values (10–21.5 °Brix) reported by Fadavi et al., 2005 and Shulman et al., (1984). The titrable acidity (as citric acid) ranged from 0.356 % in ‘Mridula’ to 0.532% in ‘Dholka’. The inter-varietal differences were highly significant. The prevalence of wide range in acid content in juice of different cultivars is probably the reason to use this character to classify pomegranate cultivars as sweet, sour or bitter sweet (Cains, 1940 and Cheema et al., 1949). Cultivar Kandhari produced the highest content of ascorbic acid in fruits (12.75 and 12.50 mg ascorbic acid / 100 ml juice), respectively as compared to ‘Kashmir Local’ (10.00 mg ascorbic acid / 100 ml juice ). Similar results were also reported by Kulkarni and Aradhya (2005) in cultivar Ganesh. The content of reducing sugar and total sugar differ significantly among the cultivars and maximum reducing sugar recorded in ‘Kandhari’ 7.50 %, ‘Bedana’ 7.12% and ‘Dholka’ 6.34 % as compared to ‘Kashmir Local’ 6.14%. However, total sugar ranged from 8.23 % in ‘Mridula’ to 9.97 % in ‘Kandhari’. The maturity index (TSS/TA) is responsible for the taste and flavor of pomegranate, which some author used for classifying the pomegranate cultivars (Martinez et al., 2006; Cam et al., 2009b).
This classification has been optimized for Spanish cultivars: maturity index (MI) = 5–7 for sour, MI = 17–24 for sour–sweet and MI = 31–98 for sweet cultivars (Martinez et al., 2006). In the similar fashion the maturity index values varied from 20.84–39.47. The cultivar Mridula had the highest MI (Table 3). In previous studies variable ranges of maturity index (Viswanath et al., 1999; Martinez et al., 2006; Cam et al., 2009a; Sarkhosh et al., 2006) were reported.

The content of juice pH ranged among cultivars from 3.85 in ‘Jyoti’ to 4.46 in ‘Kashmir Local’ (Table 3). The pH values obtained in the current study are greater than those reported by Cam et al, (2009a) on pomegranate cultivars grown in Turkey. According to the results, cultivar type plays an important role in terms of their total soluble solids, pH, titrable acidity, total sugars and maturity index of the pomegranate juice. All the cultivars investigated were suitable for direct consumption and production of pomegranate juice because they had the high levels of soluble solids. Total chlorophyll content of leaves was also varied among cultivars and the maximum chlorophyll content was recorded in ‘Dholka’ (72.56 %) followed by ‘Jyoti’ (62.76 %) and ‘Kashmir Local’ (42.66 %). Shelf life also differ according to cultivars and the maximum storage life under ambient condition (16-26 °C ) recorded in ‘Kashmir Local’ (65.26 days) followed by ‘Dholka’ (63.56 days) and ‘Bedana’ (59.53 days). These variations in vegetative growth, physico-chemical characteristics of fruits and yield were mainly due to genotypic variation of the varieties Mahajan and Dhillon, (2000), though agro-climatic conditions could not be overlooked (Mali & Prasad 1999). Anar butterfly incidence was ranged between 12.25-32.12 %, and the maximum incidence in ‘Kashmir Local’ and lowest ‘Jyoti’ similarly aphid attack recorded maximum in ‘Kashmir Local’ (23.30%) and minimum in ‘Dholka’ (10.30 %). The results reveled that ‘Kashmir Local’ is more susceptible to anar butterfly and aphid attack and ‘Jyoti’ and ‘Dholka’ are less susceptible.

CONCLUSION

The performance of eight pomegranate cultivars for vegetative growth, morphology, yield and quality attributes of fruits were evaluated for their suitability to Karewa condition of Kashmir Valley. Out the eight cultivars evaluated ‘Bedana’, ‘Chawla’ and ‘Jyoti’ were found more vigorous than others. Cultivar Dholka showed it superiority with respect to fruit set, fruit size, fruit weight, number of fruits, fruit calyx diameter and length, yield/tree, TSS, ascorbic acid, titrable acidity and minimum aphid attack while ‘Kandhari’ was superior in reducing sugar, and total sugar. However, ‘Jyoti’ was better in duration of flowering, number of Seed + Aril, minimum fruit cracking, juice pH, anar butterfly attack compared to other cultivars.

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[131]