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VARIABILITY AND CLUSTER ANALYSIS IN SAND PEAR (*PYRUS PYRIFOLIA* (BURM) NAKAI.) GENOTYPES

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Abstract

To assess the nature and magnitude of variability in sand pear genotypes of existing plantations a survey was carried out at Solan and Sirmour districts of Himachal Pradesh, India. On the basis of pre selection survey, a total of 92 healthy and bearing sand pear trees were marked during 2018-2021. Wide variation in qualitative and quantitative characters were observed for fruit (physical and biochemical) as well as yield parameters. Range for TSS, titratable acidity, total sugars, reducing sugars, non-reducing sugars, sugar acid ratio, and phenol content was observed as 10.08-18.55°B, 0.12-0.48, 4.95-12.61, 2.95-8.98, 1.01-5.40%, 14.66-68.49 and 1.66-6.40 mg/g, respectively. The cluster dendrogram to elucidate the genetic relationship was performed on the basis of studied parameters to assess pattern of diversity and variability among the accessions. The selected genotypes from existing population excelling in one or more horticultural desirable traits will not only adds to biological diversity but can also be utilized in different breeding programs for development of superior varieties based upon their utility.

Introduction

Sand pear (*Pyrus pyrifolia* (Burm) Nakai.) is a species of pear tree native to East Asia. It is second most popular fruit next to apple and the most economically important and frequently consumed fruit in temperate zone of the World (Ahmed *et al*. 2011). It belongs to family Rosaceae, subfamily Pomoideae and genus *Pyrus* with basic chromosome number of 17. Worldwide, genus *Pyrus* is characterized by high genetic variability with several species and cultivars but commercial pear production is mainly represented by *Pyrus communis* L. (European pear), *Pyrus pyrifolia* (Asian or Oriental pear) and their commercial hybrids (Ferradini *et al.* 2017). The Asian pear is distinguished by their crispness and sweet flavour, while the European pears are known for their delicate flavor and aroma. It is packed with several health benefiting nutrients such as dietary fibres, antioxidants, minerals and vitamins (Reiland and Slavin 2015). Fruits of sand pear contain pharmacological properties like anti-inflammatory, anti-tumour, antiallergic etc. (Macheix *et al*. 1990) and also help in reducing body weight.

Sand pear has great potential for cultivar improvement and enhancement of sustainability in pear industry. Hitherto, practically no efforts have been made by the researchers for the selection of superior sand pear varieties with desirable horticultural traits from these plantations present abundantly in H.P. Though, today India is on the forefront in fruit production in the world, but still need a substantial increase in productivity as well as diversification in present day horticulture to meet the demands of growing population. It requires exploitation of such types of lesser known fruits. Keeping in view the importance of sand pear genetic resources, a superior tree specific exploration survey was done to assess their possibilities in future fruit crop improvement programme.

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Materials and Methods

The present investigation was carried out on existing plantations of sand pear trees in two districts of Himachal Pradesh *viz.*, and Sirmour during 2018-2020. The region opted for research particularly falls under sub-mountain zone which stretched from N 30°49.644' to N77°56.585' with elevation ranging from 857- 1376 m above mean sea level. On the basis of pre-selection survey based on fruit size and TSS as well as feedback collected from local people and farmers in the form of questionnaire, about 350 genotypes were selected, out of which 92 genotypes were taken for further analysis (Table 1).

Table 1. Location detail of sand pear genotypes observed from district Solan and Sirmour.

Location detail of sand pear genotypes observed from district Solan				
Location	Genotype code	Elevation	Latitude	Longitude
Dharja-D	SLND (1-8)	1162	N 30°51.816'	E 077 ^{0}18.545'
Nauni-N	SLNN(1-4)	1266	N 30^{0}51.849'	E 077 ^{0}10.140'
Kyar-K	SLNK (1-3)	1298	N 30^{0}52.164'	E 077 ^{0}07.992'
Tatol- TA	SLNTA (1-3)	1235	N 30^{0}51.824'	E 077 ^{0}07.586'
Kotla-KO	SLNKO (1-2)	1270	N 30^{0}52.004'	E 077 ^{0}07.410'
Lohanji-LO	SLNLO (1-3)	1324	N 30^{0}52.650'	E 077 ^{0}04.216'
Damuri-DA	SLNDA (1-3)	1376	N 30^{0}54.599'	E 077 ^{0}01.556'
Dharampur–DH	SLNDH (1-4)	1313	N 30^{0}84.758'	E 077 ^{0}01.919'
Dagrohpul-DP	SLNDP (1)	1296	N 30^{0}54.934'	E 077 ^{0}01.811'
Subathu-S	SLNS (1-3)	1076	N 30^{0}58.608'	E 077 ^{0}56.545'
Tikkar-T	SLNT (1-5)	857.6	N 30^{0}58.501'	E 077 ^{0}56.585'
Band-B	SLNB (1-2)	856.7	N 30^{0}57.403'	E 076 ^{0}55.585'
Basthala-BA	SLNBA (1-3)	867	N 30^{0}60.501'	E 077 ^{0}56.410'
Darlaghat-DR	SLNDR (1-3)	1657	N 31^{0}17.122'	E 076 ^{0}47.568'
Location detail of sand pear genotypes observed from district Sirmour				
Maryog-M	SMRM (1-7)	955.4	N 30^{0}52.436'	E 077 ^{0}12.772'
Rajgarh-R	SMRR (1-2)	1162	N 30^{0}51.816'	E 077 ^{0}18.545'
Baryodi- B	SMRB (1-2)	947.5	N 30^{0}52.280'	E 077 ^{0}12.791'
CheolaBakanag- CB	SMRCB (1-3)	1072	N 30^{0}51.689'	E 077 ^{0}11.840'
Darodevria – DD	SMRDD (1-4)	1127	N 30^{0}50.672'	E 077 ^{0}11.626'
Pacchad- P	SMRP (1-3)	1154	N 30^{0}50.768'	E 077 ^{0}11.621'
KotlaJori- KJ	SMRKJ (1-5)	1229	N 30^{0}50.696'	E 077 ^{0}10.921'
Deothal- DE	SMRDE (1-2)	1170	N 30^{0}49.701'	E 077 ^{0}10.901'
Thaledi-T	SMRT (1-3)	1164	N 30^{0}49.936'	E 077 ^{0}09.861'
Nauhra-N	SMRN (1-2)	1156	N 30^{0}49.644'	E 077 ^{0}10.119'
Dilman- D	SMRD (1)	1131	N 30^{0}50.047'	E 077 ^{0}09.722'
Jhakdogh- J	SMRJ (1)	938.9	N 30^{0}51.689'	E 077 ^{0}11.840'
Sarahan-S	SMRS (1)	1350	N 30^{0}72.678'	E 077 ^{0}18.545'
Mehli-ME	SMRME (1-2)	1372	N 30^{0}79.878'	E 077 ^{0}17.445'
Kalaghat-KA	SMRKA (1-7)	1101	N 30^{0}50.674'	E 077 ^{0}09.185'

A total of 20 fruits were selected randomly from all directions from each individual tree at optimum maturity for evaluation. The traits considered for evaluation were fruit length, diameter, weight, juice content, depth of stalk cavity, width of eye basin, depth of eye basin, firmness, total soluble solids, total sugars, reducing sugars, non-reducing sugars and phenol content. The morphological characterization was done as per IBPGR (1983) and UPOV (2000) standard descriptor. The chemical analysis was conducted following standard protocols. Cluster analysis was performed as proposed by Tryon and Robert (1939) and dendrogram was constructed using Ward linkage based on all fruiting traits under study using PAST3 software.

Results and Discussion

Substantial variation among various fruit characters such as size, weight and quality have been utilized as reliable parameters for identification, description and classification of sand pear genotypes. Fruit length, diameter and weight were found to range from 33.18-72.10 mm, 34.42-71.53 mm and 47.70-163.70 g with coefficient of variation as 16.77, 15.35 and 25.66 %, respectively among different genotypes from Solan and Sirmour district. Cowan *et al.* (2001) reported variation in fruit size and weight might be under control of genetic factors involving their phylogenic behaviours. Length of fruit stalk ranged from 0.71 (SLNTA2) to 5.36 cm (Ha SMRDD4) with an average of 2.28 cm. Coefficient of variation was recorded as 40.05 %. Depth of stalk cavity and eye basin varied from 0.11 cm (SLNS3) to 0.91 cm (SMRR2) and 0.20 cm (SLND6) to 1.32 cm (SMRKJ5) respectively. Average value for depth of stalk cavity and eye basin was recorded as 2.28 and 0.41 cm with coefficient of variation 40.05 and 36.96 per cent, respectively. The fruit growth in *Pyrus pyrifolia* is characterized by an initial period of rapid cell division followed by long period of cell expansion (Jackson 2003). However, Stanley *et al.* (2000) reported that it might be the inherent ability of a genotype to utilize the available resources efficiently to achieve a certain fruit size. Average juice content among sampled fruits was 49.30%. Mean juice content of fruit ranged from 24.39 (SLNDH3) to 64.47 % (SLNK2). Coefficient of variation was recorded as 15.61 per cent. Fruit firmness among sampled genotypes revealed that average fruit firmness was 11.00 kg/cm^2 which ranged from 6.13 kg/cm^2 (SLNDH3) to 15.40 kg/cm^2 (SMRKA6). Coefficient of variation was recorded as 23.34 per cent. Total soluble solids (^{o}B) ranged between 10.08 (SLNB1) and 18.55 (SLNT1). An increase in TSS percentage with fruit development as a result of degradation of starch and organic acids into soluble sugars in different pear strains has been reported earlier (Dhillon *et al.* 1999, Singh 2002). Trees with high moisture availability showed less TSS content as compared to scare water supply (Wang 1982) which indicates that variability in fruit characters was not only influenced by genetic factor but also by climatic factor. Acidity ranged between 0.12 (SMRM3) and 0.48 % (SMRDE2). The average fruit acidity was 0.26% with 28.87 per cent coefficient of variation. These variations in fruit acid content might be due to different rates of conversion of organic acids into soluble sugars by different genotypes. These results are in agreement with the results reported by Verma *et al.* (2014) who recorded acid content between 0.11 to 0.40% among different pear cultivars (Fig. 1). Total sugars (%) varied from 4.95 (SLNDH2) to 12.61 (SLNT1) with an average of 7.81. Coefficient of variation was recorded as 21.76 per cent. Reducing sugars ranged from 2.95 (SMRME1) to 8.98% (SMRDE1) with an average of 5.54%. The coefficient of variation was recorded as 25.52 per cent. However, non-reducing sugars ranged from 1.01 (SMRM6) to 5.40% (SLNT2) with an average of 2.27 %. Coefficient of variation was recorded as 38.13 per cent. Sugar acid ratio varied between 14.66 (SMRCB3.) and 68.49% (SMRM3) with an average of 32.07%. Coefficient of variation was recorded as 32.48 %. Phenol content (mg/g) in sampled sand pear fruit varied from 1.66 (SLNT5) to 6.40 (SLNB1) with an average of 3.34. The coefficient of variation was recorded as 33.89%.

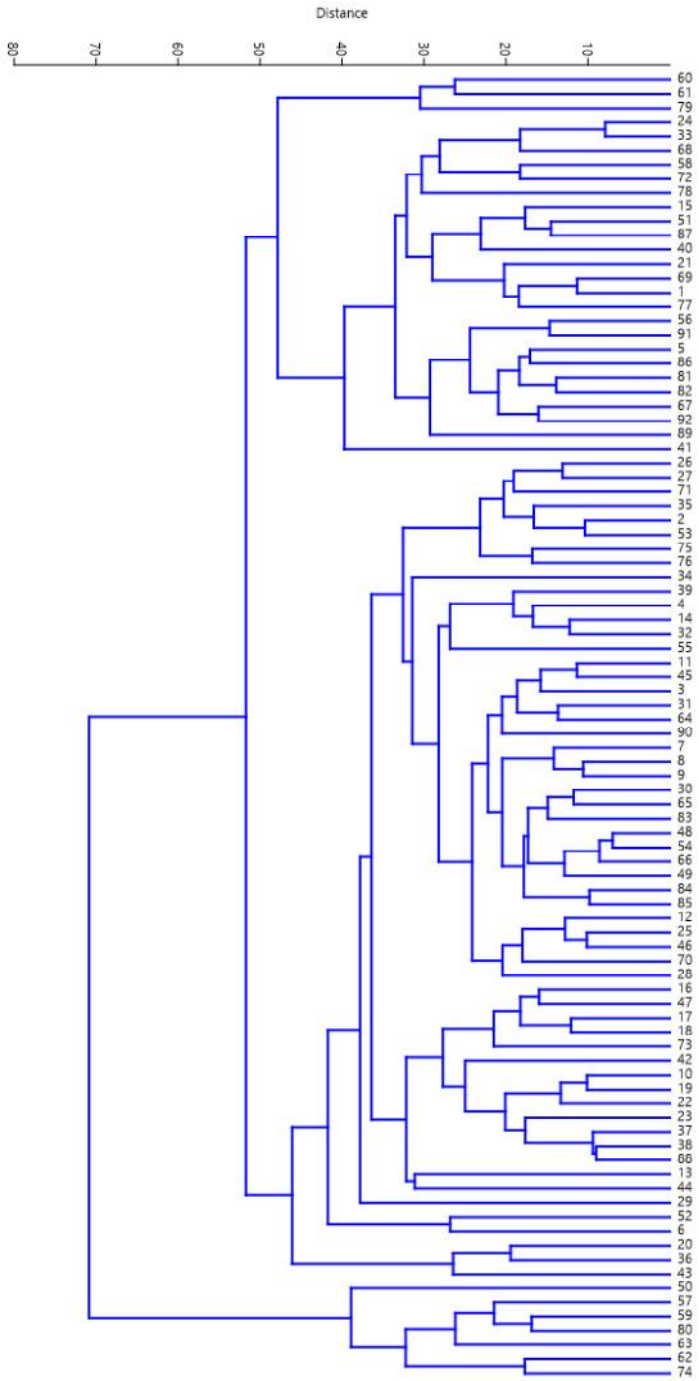

Fig. 1. Cluster diagram based on the yield and fruit characters of sand pear genotypes from district Solan and Sirmour district.

The variation in terms of yield was found to range from 36.00 (SMRT1) to 94.00 kg/plant (SMRDD1) with an average of 62.70 kg fruits per plant. Coefficient of variation was 21.99 %. These variations in yield parameters might be attributed to several factors like differences in the number of blossoms, final fruit set, fruit number, fruit and tree size. Further severe climatic conditions and location significantly affected flower bud formation and bud abortion in pear (Verissimo *et al.* 2002). Yield efficiency ranged between 0.09 (SMRM6) and 1.55 kg/cm^2 (SMRS1) with an average of 0.32 kg/cm^2 which might be due to difference in yield and tree vigour mong several genotypes (Fig. 1). This observation was also reported by Iglesias (2008). The coefficient of variation was recorded as 77.21 per cent.

Ninety two genotypes of sand pear genotypes based on 19 characters (fruit quality and yield) were grouped in two major clusters and three sub clusters (Fig. 2). The numbers of genotypes in cluster I were seven (7.60 %) and in cluster II the number of genotypes were 85 (92.39%). Cluster I of dendrogram consisted of one sub cluster comprised of seven genotypes, whereas Cluster II included two sub clusters. Sub cluster I comprised of 27 genotypes and the sub cluster II comprised of 58 genotypes. Cluster analysis helps in determining the variation among different sand pear genotypes of similar expressions as well as deals with distribution of data into number of clusters.

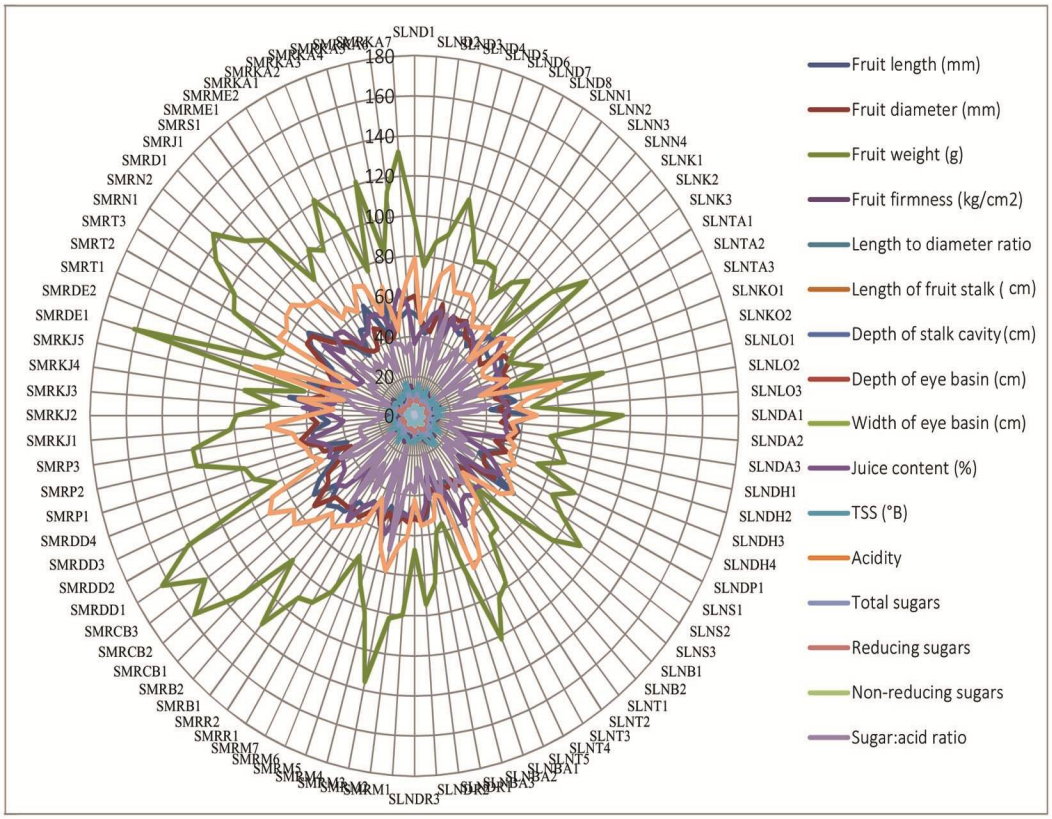

Fig. 2. Variation among sand pear genotypes for fruit and yield parameters.

In the present study, the variation recorded in terms of yield and quality parameters of existing plantations of sand pear raised on variable rootstock, resulted through seed dispersal might be due to entire nuclear genome transfer between plant cells and across the graft junction as reviewed and reported in different plant and fruit species by Zhou and Liu (2015). This variation will enable the researchers, in collaboration with farmers, as a way forward to promote sand pear cultivation by utilizing indigenous genetic wealth in different breeding programs for development of superior varieties.

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