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Evaluation of Genetic Diversity in Wild Pear (*Pyrus pashia*) under Kumaon Hills of Uttarakhand

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Abstract A survey was conducted for evaluation of genetic diversity in wild pear (*Pyrus pashia*). During the survey, total nine accessions of wild pear were collected and accessed for their important morphological traits. A considerable variability in morphological, fruiting and seed characteristics was observed among the accessions. Majority of the accessions are upright and spreading in growth habit, medium to large in size and less infected with diseases and insect pests. The leaf size is ranged between 3.86–9.50 cm in length and 2.45–6.17 cm in width, the leaf petiole length is ranged from 1.09–6.17 cm. The fruits are small to medium in size (1.45–3.60 cm in length and 1.61–4.62 cm in width), round in shape and light brown in color. The fruit weight ranged from 2.88–48.82 g and having 7—15 °B TSS. The number of seeds fruit ranged from 6.00 to 10.67, seed length 0.52 to 0.73 cm, seed width 0.31 to 0.60 cm, seed index 0.29 to 2.35 g and seed germination percentage 52.82% to 95.57%. The collector no. SKV/RRA/AK/1844 recorded the highest leaf size (9.50 cm length and 6.17 cm width), fruit size (3.60 cm length and 4.60 cm width), fruit peduncle length (2.60 cm), TSS (15 °B) and seed size (0.73 cm length and 0.60 cm width) as compared to the other accessions. These results suggested that variability accounted for these traits was due to either genotypes or environmental conditions prevailing in the growing areas or interaction of both the factors.

Keywords *Pyrus pashia*, Collection, Diversity, Evaluation, Variability.

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Introduction

Plant genetic resources of cultivated crop plants as well as wild relatives have significant values to mankind as they provide food, fuel, shelter and industrial products. Further, plant breeders require genetic variation for plant improvement. Genetic diversity in wild relatives is very important, as these contain genes resistant to biotic and abiotic stresses. Thus, all unique accessions need to be collected, characterized and preserved [1]. *Pyrus* germplasm have rich source of genetic variability as accumulated through hybridization, mutation and naturally seed based propagation. The wild populations of *Pyrus pashia* commonly known as Mehal or kainth or Shaira are grown all over the Himalayas at an altitude between 700 to 2000 m, from where it is believed to be originated [2]. *Pyrus pashia* is considered an intermediate species between oriental and occidental pear groups and may have played an important role in the evolution of the *Pyrus* genus [3, 4]. The *Pyrus pashia* trees

are tall, vigorus and spreading in nature and yielding small to large roundish fruits which are very poor in quality with an abundance of grit cells. It is easy to propagate through stooling but gives very poor rooting in air layers. It is also used as a rootstock for pear cultivars in Himachal Pradesh and Uttarakhand [5, 6]. It is resistant to powdery mildew caused by *Podosphaera leucotricha* [7] and white root rot caused by *Dematophora necatrix* [8]. It possesses profuse root volume with deep root system and recommended as rootstock for steep slopes, soils with moisture stress conditions and root rot infested areas [9].

Pyrus species particularly wild populations are threatened worldwide with about more than 85% pear varieties lost in the 19th century, continuing even today [10]. Furthermore, due to various insect-pests and pathogens, valuable and highly resistant to various abiotic stresses pear germplasm has been lost [11]. Proper attention for exploration, collection, conservation and characterization of genetic resources of *Pyrus* germplasm is an urgent need. Therefore, the conservation of *Pyrus pashia* is of significant importance for both commercial use and research. To conserve germplasm resources of *Pyrus pashia* efficiently, it is necessary to evaluate its genetic diversity. To date, few studies of the genetic diversity of *Pyrus pashia* in Kumaon hills of Uttarakhand have been reported, and this strongly hampers the conservation, management and use of the species. Therefore, the aim of the study was to characterise genetic diversity based on morphological and fruiting parameters and screen out the plant material for horticultural interest. The promising genotypes can be promoted for nursery trade, rootstock production and to use in breeding programs. Keeping this in view, the present investigation was undertaken to collect and evaluate the available genetic diversity of wild pear (*Pyrus pashia*) in Kumaon hills of Uttarakhand.

Materials and Methods

The survey and collection tour was done in fruit maturing stage during September 2014 in Bageshwar, Champawat and Pithoragarh districts of Uttarakhand to access the genetic diversity of wild pear (*Pyrus pashia*). Formal and informal conversation with local farmers was adopted as a strategy to collect the information about the wild pear (*Pyrus pashia*) germplasm available in the area. In each village four to five farmers were consulted before identification of a genotype for collection. Accessions were collected randomly at fruit maturity stage from different sites of these districts and marked with durable label (aluminium sheet) during survey. The available diversity of wild pear (*Pyrus pashia*) frequently found in the forest, fellow and cultivated habitats of the area were collected from population through selective sampling technique along with passport information. Tree growth habit, tree shape, incidence of diseases and insect pest, leaf size (cm), leaf petiole length (cm), fruit shape, fruit color, fruit size (cm), fruit weight (g), fruit peduncle length (cm), TSS (°B), number of seeds/fruit, seed size (cm), seed index (g) and seed color were the main parameters for identifying a genotype for collection. Observations on physical characteristics of leaves, fruits and seeds were recorded using standard methods [12]. Fruits of identified accessions were collected and seed germination percentage was estimated in the laboratory following the standard method [13]. The observations were subjected to statistical analysis by using randomized block design as per procedure given earlier [14].

Results and Discussion

The list of 9 accessions of wild pear (*Pyrus pashia*) collected from forest, fellow and cultivated habitats of surveyed area are shown in Table 1. Accessions collected show upright and spreading growth habit, medium to large in size with more vertical branching which helps in proper light interception and growth of plants. Disease and insect pest incidence was noted on leaves and fruits but in most of the cases fruits were free from diseases. Most of the fruits are round in shape, light brown in color (Table 2) and having black color seeds similar results have also been reported earlier that wild pears (*Pyrus pashia*) are tall, vigorous and spreading in nature and yielding small to large roundish fruits, light to dark brown in color, which become soft and sweet to some extent when ripened but gritty and astringent with poor quality [15, 16]. Morphological and physico-chemical characteristics are influenced by genetic and environmental factors. However, genetic variability in *Pyrus* species is probably due to natural selection, genetic

Table 1. Passport data of wild pear accessions collected during exploration.

Sl. No.	Collector No.	Botanical name	Vernacular name	District	Altitude (m)	Latitude	Longitude
1.	SKV/RRA/AK/1844	*Pyrus pashia*	Mehal	Bageshwar	1450	29°90´55´´N	79°61´51´´E
2.	SKV/RRA/AK/1845	*Pyrus pashia*	Mehal	Pithoragarh	1400	29°82´44´´N	80°14´06´´E
3.	SKV/RRA/AK/1846	*Pyrus pashia*	Mehal	Pithoragarh	1500	29°35´36´´N	80°13´49´´E
4.	SKV/RRA/AK/1847	*Pyrus pashia*	Mehal	Pithoragarh	1350	29°35´14´´N	80°11´55´´E
5.	SKV/RRA/AK/1848	*Pyrus pashia*	Mehal	Pithoragarh	1350	29°35´14´´N	80°11´55´´E
6.	SKV/RRA/AK/1849	*Pyrus pashia*	Mehal	Pithoragarh	1350	29°35´14´´N	80°11´55´´E
7.	SKV/RRA/AK/1851	*Pyrus pashia*	Mehal	Pithoragarh	1500	29°33´38´´N	80°13´55´´E
8.	SKV/RRA/AK/1852	*Pyrus pashia*	Mehal	Champawat	1650	29°38´99´´N	80°15´02´´E
9.	SKV/RRA/AK/1853	*Pyrus pashia*	Mehal	Champawat	1754	29°32´98´´N	80°09´55´´E

diversification and environmental impacts [17]. Therefore, variability available with respect to these traits was collected up to maximum possible extent. Exploration and collection of germplasm and morphological characterization provides a base and raw picture of germplasm of specific plant species about variability and genetic diversity. These characters can be used as a base for further study at molecular level [18].

Table 3 exhibits significant variations in leaf size, leaf petiole length, fruit size, fruit weight and TSS content, however the fruit peduncle length differs non-significantly among the different accessions. The highest leaf size (9.50 cm length and 6.17 cm width), fruit size (3.60 cm length and 4.60 cm width) and fruit peduncle length (2.60 cm) was recorded in collector no. SKV/RRA/AK/1844. The highest leaf petiole length (3.90 cm) was recorded in collector no. SKV/RRA/AK/1846 which was statistically *at par* with collector no. SKV/RRA/AK/1848 and SKV/RRA/AK/1851 i.e., 3.70 cm and 3.63 cm, respectively. The highest fruit weight was (48.82 g) was recorded in collector no. SKV/RRA/AK/1853 followed by collector no. SKV/RRA/AK/1844 i.e., 32.52 g. The highest TSS content (15 °B) was recorded in both collectors no. SKV/RRA/AK/1844 and SKV/RRA/AK/1853. The collector no. SKV/RRA/AK/1845 recorded the lowest leaf size (3.86 cm length and 2.45 width) and leaf petiole length (1.09 cm). The lowest fruit size (1.45 cm length and 1.61 cm width) and fruit weight (2.88 g) was recorded in collector no. SKV/RRA/AK/1847. The collector no. SKV/RRA/AK/1852 and SKV/RRA/AK/1848 recorded the lowest fruit peduncle length (1.57 cm) and TSS content (7.00 °B) respectively. Present observations are strongly supported by earlier findings [19] who reported remarkable diversity in leaf and fruit characteristics in temperate fruits. According to Palmer [20], the amount, size and arrangement of leaves, branches, tree shape and size depend

Table 2. Growth and fruiting characteristics of wild pear accessions collected during exploration.

Sl. No.	Collector No.	Growth habit	Tree size	Incidence of pest and diseases	Fruit shape	Fruit color
1.	SKV/RRA/AK/1844	Upright	Medium to large	No visible symptoms	Apple shaped	Brown
2.	SKV/RRA/AK/1845	Upright	Medium to large	No visible symptoms	Round	Light brown
3.	SKV/RRA/AK/1846	Upright	Large	No visible symptoms	Round	Light brown
4.	SKV/RRA/AK/1847	Upright	Small to medium	Highly infected	Round	Light brown
5.	SKV/RRA/AK/1848	Upright	Medium to large	Partially infected	Elongated	Light brown
6.	SKV/RRA/AK/1849	Upright	Large	No visible symptoms	Round	Light brown
7.	SKV/RRA/AK/1851	Upright	Medium to large	No visible symptoms	Round	Light brown
8.	SKV/RRA/AK/1852	Upright	Medium to large	No visible symptoms	Round	Light brown
9.	SKV/RRA/AK/1853	Upright	Large	No visible symptoms	Apple shaped	Brown

Table 3. Leaf and fruit characteristics of wild pear accessions collected during exploration.

Sl. No.	Collector No.	Leaf size (cm) Length	Width	Leaf petiole length (cm)	Fruit size (cm) Length	Width	Fruit peduncle length (cm)	Fruit weight (g)	TSS (°B)
1.	SKV/RRA/AK/1844	9.50	6.17	2.88	3.60	4.62	2.60	32.52	15.00
2.	SKV/RRA/AK/1845	3.86	2.45	1.09	2.17	2.52	2.50	6.82	11.00
3.	SKV/RRA/AK/1846	9.47	5.00	3.90	1.73	1.83	2.16	8.67	9.00
4.	SKV/RRA/AK/1847	5.77	2.73	2.33	1.45	1.61	2.33	2.88	12.00
5.	SKV/RRA/AK/1848	8.97	3.60	3.70	2.38	2.21	2.40	5.65	7.00
6.	SKV/RRA/AK/1849	9.33	4.03	2.80	2.33	2.35	2.36	6.50	8.00
7.	SKV/RRA/AK/1851	6.90	3.07	3.63	1.99	2.01	1.97	6.40	8.00
8.	SKV/RRA/AK/1852	6.19	2.50	2.33	2.69	2.88	1.57	8.19	14.00
9.	SKV/RRA/AK/1853	6.93	3.67	2.47	3.47	3.97	1.87	48.82	15.00
	CD at 5%	1.96	1.10	1.33	0.34	0.32	NS	0.39	0.54
	SEm±	0.65	0.36	0.44	0.11	0.11	0.22	0.13	0.18

upon light penetration into the tree. In conformity with the present findings Paganova [21] described variability in fruit shapes as round or apple shaped and ovate to oblong in various *Pyrus* genotypes. Fruit size is generally 0.5–20 cm long with or without grit cell. Ground color changes from green to yellow or red during maturation. Browning russet is mainly due to increase in humidity. Most of the morphological characteristics of fruit are under polygenetic control [22]. Variability in fruit traits especially the shape of fruits (round, oblong and pyriform) is controlled by genetic factors whereas environmental conditions influence on size of the fruits i.e. small, medium, large and very large [23]. This variability in TSS might also be due to variable climatic conditions mainly temperate and precipitation, as there is considerable variation in rainfall within the study area. Trees with high moisture availability showed less TSS compared to scarce water supply with higher TSS content in *Pyrus* species [24]. This indicated that the variability in fruit characteristics especially in fruit composition was not only due to genetic factors but also influenced by climatic factors. Chen et al. [25] found that different *Pyrus* germplasm have different chemical compositions that is influenced by prevailing environmental conditions.

The observations on the seed characteristics such as number of seeds/fruit, seed size, seed index and seed germination percentage exhibited consider-

Table 4. Seed characteristics of wild pear accessions collected during exploration.

Sl. No.	Collector No.	Number of seeds/fruit	Seed size (cm) Length	Width	Seed index (g)	Seed color	Seed germination (%)
1.	SKV/RRA/AK/1844	7.00	0.73	0.60	2.35	Brown	86.36
2.	SKV/RRA/AK/1845	7.67	0.62	0.36	1.28	Black	64.28
3.	SKV/RRA/AK/1846	6.00	0.60	0.34	0.40	Black	67.41
4.	SKV/RRA/AK/1847	7.00	0.52	0.32	0.52	Black	81.57
5.	SKV/RRA/AK/1848	8.00	0.54	0.31	1.90	Black	95.57
6.	SKV/RRA/AK/1849	8.00	0.61	0.35	0.29	Black	52.82
7.	SKV/RRA/AK/1851	10.67	0.71	0.35	1.55	Black	92.95
8.	SKV/RRA/AK/1852	6.33	0.60	0.33	1.21	Black	74.13
	SKV/RRA/AK/1853	8.00	0.71	0.41	2.91	Black	65.36
	CD at 5%	0.84	0.07	0.03	0.06	–	2.74
	SEm±	0.28	0.02	0.01	0.02	–	0.90

able variations among the different accessions (Table 4). The highest number of seeds / fruit (10.67) was recorded in collector no. SKV/RRA/AK/1851, while the lowest (6.00 and 6.33) was recorded in collector no. SKV/RRA/AK/1846 and SKV/RRA/AK/1852, respectively. The collector no. SKV/RRA/AK/1844 recorded the highest seed size i.e. 0.73 cm length and 0.60 cm width, however the lowest seed size was recorded in collector no. SKV/RRA/AK/1847 and SKV/RRA/AK/1848 i.e. 0.52 cm and 0.54 cm length and 0.32 cm and 0.31 cm width respectively. The seed index was recorded highest (2.91 g) in collector no. SKV/RRA/AK/1853 followed by collector no. SKV/RRA/AK/1844 i.e., 2.35 g, while the lowest (0.29 g) was recorded in collector no. SKV/RRA/AK/1849. The highest germination percentage was recorded in collector no. SKV/RRA/AK/1848 i.e., 95.57% followed by collector no. SKV/RRA/AK/1851 i.e., 92.95% while the lowest (52.82%) was recorded in collector no. SKV/RRA/AK/1849. The variability in seed characteristics observed in these wild pear (*Pyrus pashia*) accessions may be due to hybridization, sexual propagation, bud mutation and diverse agro-ecological conditions. Similar observations related to wild, primitive varieties and landraces for other temperate fruits have also been reported [26, 27]. Muratovic et al. [28] have also emphasized that superior *Pyrus* species should be selected and conserved in field in mountainous areas for crop improvement. Low level of variability in cultivated pear genotypes is alarming the need to widen the genetic base to conserve an adequate level of genetic diversity for breeding programs [29]. From this study, it can be concluded that the collected valuable material may be evaluated as rootstock for its compatibility, resistant to biotic and abiotic stresses and fruit quality on different commercially grown pear cultivars. It will help to have elite and good quality planting material which in turn will increase the area and production of pear cultivars in India.

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