Germplasm Evaluation of Low-chill Pears (*Pyrus* spp.) for Vegetative, Reproductive and Fruit Quality Parameters in Tarai Area of Uttarakhand

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Twenty-one low-chill pear germplasm were evaluated for plant growth, fruit yield and fruit quality parameters at Horticulture Research Centre, Patharchatta, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, during 2001-02 to 2003-04 for various vegetative, reproductive and yield parameters. The mean performance values for tree height (10.0 m) and trunk girth (56.8 cm) indicated larger values for Pant Pear-18 and LeConte, respectively. The maximum canopy spread (5.1 m) was recorded in *Pyrus pashia* and Pant Pear-18, respectively. Among fruit quality traits maximum fruit weight was recorded in Pant Pear-3 (11.3 g), fruit length in China (8.7 cm), TSS in LeConte (15.2%), acidity in Tumaria (0.37), total sugar in LeConte (9.1%) and fruit yield in Pant Pear-3 (26.5 q/ha) during the study. The variability observed in the pear germplasm can be used for the genetic improvement of fruit yield and quality.

Key Words: Evaluation, Fruit quality, Fruit yield, Low-chill pear, *Pyrus* spp.

Introduction

The productivity of pear in Asian countries is 6.6 t/ha, while in India, it is nearly 6.00 t/ha (Gemman, 2002). Pear is one of the few fruit crops that are adaptable to wide variety of climatic conditions. The agro-climatic conditions of Uttaranchal in foothill of Sivalik range of Himalaya are well suited for the cultivation of low chill pears. Considerable variation occurs in the adoption of pear cultivars in a particular set of agro-climatic conditions due to variability in macro and micro-climate. The availability of cultivar variability is a pre-requisite for breeding of any fruit crop. Particular attention is desirable on improvement of agronomic and pomological characteristics, such as tree vigour, productivity, appearance, quality and yield. Knowledge of heritability of main characteristics is very important for the successful breeding work. The first step is long-term evaluation of varieties in the field, in genebanks or in cropping plantations. The second step has to be the testing of parents and populations (Fischer, 2009). *Pyrus* is genetically quite diverse, with considerable variability in morphological and physiological adaptations (Lombard and Westwood 1987; Bell *et al.*, 1996). European and Asian pear breeders have utilized this variability to develop high quality cultivars with large size and attractive appearance that are well adapted to local conditions (Hancock and Lobos, 2008). Pear cultivar Gola, Tumaria and Bagugosha are the promising cultivars of Uttarakhand. Therefore, the collected pear germplasm at Horticulture Research Centre, Patharchatta, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand were evaluated for their performance in terms of plant growth, fruit yield and fruit quality.

Materials and Methods

Twenty-one experimental trees comprising 12 to 13 years old bearing trees of 13 pear seedling selections (Pant Pear-1, Pant Pear-2, Pant Pear-3, Pant Pear-4, Pant Pear-5, Pant Pear-6, Pant Pear-7, Pant Pear-9, Pant Pear-10, Pant Pear-13, Pant Pear-15 and Pant Pear-18), six varieties (Patharnakh, Smith, Kieffer, Tumaria, China, LeConte and Thumb Pear) and two rootstocks (Mehal and Sand Pear) were planted at 5×5 m distance in square system. The experimental site is situated in the foothills of the Shivalik ranges of the Himalaya at 29°N latitude and 79.3°E longitude and at an altitude of 243.84 metres above mean sea level. The experiment was carried out in a randomized block design with three replications and each treatment had four trees/replication. The data on tree growth, yield and fruit quality were recorded. The physicochemical parameters were analyzed as per the method described in AOAC (1970). Growth parameters and physical fruit quality was determined following Mahajan *et al.* (2002). The TSS of the fruit juice was estimated with the help of hand refractometer by adjusting at 20°C by temperature correction chart. The sugar was assessed by the method of Lane and Eynon (1943). Titrable acidity was determined with the standard alkali

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solution and expressed in terms of malic acid.

Results and Discussion

Vegetative Parameters

All the parameters were recorded and analyzed by taking Patharnakh as standard germplasm for the evaluation (Table 1). Tree height of the plants varied from 4.0 m (Pant Pear-13) to 10.0 m (Pant Pear-18) among the selected germplasm. Significant difference was observed in all the selected germplasm for tree height as compared to Patharnakh. Maximum trunk girth of 56.9 cm in Patharnakh and minimum of 19.3 cm in Pant Pear-6 was recorded with no significant difference amongst Patharnakh with Pant Pear-1, Mehal, Kieffer and LeConte. Mean value for the canopy spread varied from 0.5 m (Pant Pear-6) to 5.1 mm (Mehal). Pant Pear-3, Pant Pear-18 and Mehal showed no significant difference for canopy spread with reference to Patharnakh whereas all other selected germplasm were significantly different from Patharnakh. Tree habit showed that majority plants (Pant Pear-1, Pant Pear-2, Pant Pear-4, Pant Pear-5, Pant Pear-6, Pant Pear-9, Pant Pear-10, Pant Pear-15, Patharnakh, Smith, Sand Pear, Le Conte and Thumb Pear) were upright in growth, whereas, others were spreading (Pant Pear-3, Pant Pear-7, Pant Pear-13, Pant Pear-18, Tumaria and China). Drooping (Keiffer) and weeping (Mehal) types of plants were also recorded. Vigour of the tree varied from extremely weak (Pant Pear-10, Keiffer) to weak (Pant Pear-13 and China), intermediate (Pant Pear-1, Pant Pear-5, Pant Pear-18, Patharnakh, Sand Pear and LeConte), vigorous (Pant Pear-2, Pant Pear-3, Pant Pear-6, Pant Pear-7, Pant Pear-15, Mehal, Smith and Thumb Pear) and very vigorous (Pant Pear-4, Pant Pear-9 and Tumaria), respectively. The findings were in agreement with Prakash (2000) and Singh *et al.* (2001).

Reproductive Parameters

Data indicated (Table 2) that early flowering was recorded in the germplasm of Pant Pear-1 (8-10 February), Pant Pear-2 (8-11 February), Pant Pear-4 (6-8 February), Pant Pear-5 (8-9 February), Pant Pear-10 (7-9 February), Pant Pear-13 (8-10 February), Pant Pear-18 (8-10 February), Patharnakh (7-9 February), Smith (7-9 February) and Sand Pear (5-8 February) whereas, late flowering was recorded for Pant Pear-7 (14-17 February), Pant Pear-9 (19-21 February), Pant Pear-3 (20-22 February), Pant Pear-6 (22-24 February), Mehal (14-16 February), Kieffer (20-21 February), Tumaria (25-27 February), China (24-26 February), LeConte (22-25 February) and Thumb Pear (22-26 February). In the early flowering groups flowering varied from 5th to 10th February, whereas in the late flowering groups varied from 14th to 21st March. The end of Flowering in early groups was recorded from 1st to 8th March whereas in the late group the

Table 1. Vegetative parameters of *Pyrus* spp. germplasm

Germplasm	Tree habit	Tree vigour	Tree height (m)	Trunk girth (cm)	Canopy spread (m)
Pant Pear-1	Upright	Intermediate	8.7	55.8	4.0
Pant Pear-2	Upright	Vigorous	7.6	47.9	4.0
Pant Pear-3	Spreading	Vigorous	9.2	50.0	5.0
Pant Pear-4	Upright	Very Vigorous	7.7	46.3	4.3
Pant Pear-5	Upright	Intermediate	6.1	39.4	2.9
Pant Pear-6	Upright	Vigorous	4.8	19.3	0.5
Pant Pear-7	Spreading	Vigorous	6.9	45.5	4.1
Pant Pear-9	Upright	V Vigorous	8.2	24.9	1.0
Pant Pear-10	Upright	Extremely weak	6.1	46.1	4.2
Pant Pear-13	Spreading	Weak	4.0	28.2	2.6
Pant Pear-15	Upright	Vigorous	5.5	20.5	1.1
Pant Pear-18	Spreading	Intermediate	10.0	50.0	5.1
Patharnakh	Upright	Intermediate	9.7	56.9	5.0
Mehal	Weeping	Vigorous	9.1	55.9	5.1
Smith	Upright	Vigorous	9.3	54.1	4.5
Kieffer	Drooping	Extremely weak	4.5	56.0	4.7
Tumaria	Spreading	V Vigorous	8.8	53.3	4.4
China	Spreading	Weak	7.6	50.3	3.9
Sand Pear	Upright	Intermediate	8.2	50.3	4.0
Le Conte	Upright	Intermediate	6.6	56.8	3.5
Thumb Pear	Upright	Vigorous	7.6	43.5	3.6
SEm±	–	–	0.1	0.4	0.4
LSD (P= 0.05)	–	–	0.2	1.2	0.4

PNN = Pyrifirm narrow neck; M = medium; V = very

Table 2. Reproductive parameters of *Pyrus* spp. germplasm

Genotypes	Date of flower setting	Date of end of flowering	Date of full bloom	Date of fruiting	Date of harvest	Duration of bloom (days)
Pant Pear-1	8-10 Feb	3-8 Mar	16-20 Feb	5-10 Mar	4-7 Jul	5
Pant Pear-2	8-11 Feb	3-7 Mar	15-18 Feb	5-11 Mar	5-7 Jul	4
Pant Pear-3	20-22 Feb	12-16 Mar	28-2 Mar	15-18 Mar	25-30 Jul	4
Pant Pear-4	6-8 Feb	2-6 Mar	14-17 Feb	5-8 Mar	3-8 Jul	4
Pant Pear-5	8-9 Feb	3-5 Mar	17-19 Feb	6-9 Mar	4-8 Jul	3
Pant Pear-6	22-24 Feb	18-21 Mar	28-3 Mar	20-23 Mar	2-5 Aug	4
Pant Pear-7	14-17 Feb	4-7 Mar	22-25 Feb	6-10 Mar	6-9 Aug	4
Pant Pear-9	19-21 Feb	15-18 Mar	27-1 Mar	17-21 Mar	3-6 Aug	3
Pant Pear-10	7-9 Feb	4-7 Mar	14-17 Feb	6-9 Mar	3-7 Aug	4
Pant Pear-13	8-10 Feb	3-7 Mar	16-18 Feb	5-10 Mar	4-8 Jul	5
Pant Pear-15	22-24 Feb	17-21 Mar	2-6 Mar	20-24 Mar	24-30 Jul	5
Pant Pear-18	8-10 Feb	2-7 Mar	16-19 Feb	3-9 Mar	4-9 Jul	4
Patharnakh	7-9 Feb	2-6 Mar	14-17 Feb	4-8 Mar	2-8 Jul	4
Mehal	14-16 Feb	8-11 Mar	22-25 Feb	11-15 Mar	25 Jul- 2 Aug.	4
Smith	7-9 Feb	2-5 Mar	15-17 Feb	4-8 Mar	4-8 Jul	3
Kieffer	20-21 Mar	14-18 Mar	27-30 Mar	16-20 Mar	30 Jul- 6 Aug.	5
Tumaria	25-27 Feb	18-21 Mar	9-11 Mar	20-23 Mar	2-7 Aug	3
China	24-26 Feb	16-18 Mar	8-10 Mar	19-21 Mar	1-6 Aug	3
Sand Pear	5-8 Feb	1-6 Mar	13-16 Feb	3-9 Mar	1-6 Aug	4
Le Conte	22-25 Feb	19-22 Mar	6-9 Mar	22-25 Mar	2-7 Aug	4
Thumb Pear	22-26 Feb	20-23 Mar	5-8 Mar	23-25 Mar	4-9 Jul	4

end was recorded from 4th to 23rd March. Full bloom in early germplasm was recorded from 3rd to 15th March with 3-5 days full bloom duration. While in late germplasm full bloom varied from 6th to 30th March with full bloom duration also of 3-5 days. Among the early flowering germplasm fruit set was recorded from 3rd to 11th March whereas in the late flowering germplasm fruit set varied from 6th to 25th March. The findings were in agreement with Mann and Singh (1985), Kumar (1996), Prakash (2000) and Singh *et al.* (2001).

Morphological fruit quality

The data (Table 3) revealed significant variation amongst the pear germplasm for various parameters. All the data recorded for different germplasm was compared with Patharnakh, perhaps the standard low chill germplasm. Mean value of fruit weight varied significantly from 34.2 g (Mehal) to 113.3 g (Pant Pear-3). Significant difference in germplasm was recorded for Pant Pear-3, Pant Pear-5, Pant Pear-10, Pant Pear-13, Mehal, Smith, Sand pear and Thumb pear with respect to Patharnakh. Whereas, other germplasm exhibited no significant difference for the fruit weight. Fruit length mean value varied from 4.3 (Mehal) to 8.7 cm (China). All the germplasm under study showed significantly different fruit weight and width with respect to Patharnakh except LeConte. Mean value of fruit width varied from 4.8 cm (Pant Pear-4 and Pant Pear-10, respectively) to 7.0 cm (Patharnakh). Four types of fruit shape were recorded during the study. Round (Pant Pear-2, Pant Pear-4, Pant Pear-10, Pant Pear-13, Pant Pear-18, Patharnakh, Smith, Mehal and Thumb Pear), globose (Pant Pear-7), pyriform (Pant Pear-1, Pant Pear-3, Pant Pear-5, Pant Pear-6, Pant Pear-9, Pant Pear-15, Smith, Kieffer, Tumaria and Sand Pear) and pyriform with narrow neck (LeConte and China). Among the smooth, medium rough and rough surfaces, smooth surface was recorded for Pant Pear-3, Pant Pear-6, Pant Pear-7, Pant Pear-9, Pant Pear-15, Tumaria, China LeConte and Thumb Pear, whereas medium rough for Pant Pear-1, Pant Pear-2, Pant Pear-4, Pant Pear-5, Pant Pear-18, Patharnakh, Kieffer and Sand Pear and rough for Pant Pear-10, Pant Pear-13, Mehal and Smith. Pant Pear-3, Pant Pear-6, Tumaria, China, LeConte and Thumb Pear recorded very high pulp juiciness. Whereas, high (Pant Pear-1, Pant Pear-5, Pant Pear-7, Pant Pear-9, Patharnakh and Kieffer), medium (Pant Pear-2, Pant Pear-4, Pant Pear-15, Pant Pear-18, Smith and Sand Pear) and less (Pant Pear-10, Pant Pear-13 and Mehal) were observed in the germplasm. Pulp taste of the selected germplasm varied from acidic (Pant Pear-10 and Mehal) to sub acidic (Pant Pear-9 and Kieffer) to medium sweet (Pant Pear-3, Pant Pear-4, Pant Pear-18, Smith and Sand Pear); Pant Pear-1, Pant Pear-5, Pant Pear-6, Pant Pear-7, Pant Pear-13, Pant Pear-15, Patharnakh and Thumb Pear were sweet. Pant Pear-2, Tumaria, China and LeConte were

Table 3. Fruit quality and yield of *Pyrus* spp. germplasm

Germplasm	Fruit shape	Pulp juice	Pulp taste	Gritt cells	Fruit surface texture	Pulp texture	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	TSS %	Acidity	Total Sugar	Yield (q/hac)
Pant Pear-1	Pyriform	High	Sweet	M	M rough	Soft	89.2	5.1	5.0	10.2	0.27	6.4	16.8
Pant Pear-2	Round	M	Highly sweet	M	M rough	Soft	90.8	5.4	5.2	11.0	0.23	7.0	18.2
Pant Pear-3	Pyriform	V high	M sweet	Low	Smooth	Melting	113.3	6.6	6.3	14.3	0.17	9.0	26.5
Pant Pear-4	Round	M	M sweet	M	M rough	M	85.8	5.1	4.8	10.3	0.27	6.4	18.3
Pant Pear-5	Pyriform	High	Sweet	M	M rough	Soft	106.7	5.2	5.2	13.5	0.27	7.3	19.5
Pant Pear-6	Pyriform	V high	Sweet	Low	Smooth	Soft	115.8	6.5	6.0	14.6	0.26	8.3	23.8
Pant Pear-7	Globose	High	Sweet	M	Smooth	Soft	91.7	6.3	6.0	12.5	0.18	8.0	18.7
Pant Pear-9	Pyriform	High	Sub acidic	Low	Smooth	Soft	94.2	7.1	6.3	13.4	0.18	8.1	20.7
Pant Pear-10	Round	Less	Acidic	High	Rough	M	52.5	5.0	4.8	10.3	0.27	6.6	12.7
Pant Pear-13	Round	Less	Sweet	High	Rough	M	56.7	5.3	5.3	10.2	0.26	7.0	11.7
Pant Pear-15	Pyriform	M	Sweet	M	Smooth	Soft	85.8	6.3	6.1	12.2	0.27	7.3	15.9
Pant Pear-18	Round	M	M sweet	M	M rough	Soft	89.2	6.4	6.3	12.3	0.28	7.3	18.1
Patharnakh	Round	High	Sweet	M	M rough	Soft	93.3	7.6	7.0	12.4	0.25	8.0	19.5
Mehal	Round	Less	Acidic	High	Rough	Hard	34.2	4.3	5.0	9.1	0.24	6.1	10.2
Smith	Round	M	M sweet	M	Rough	M	78.3	6.3	6.1	10.9	0.27	7.0	17.1
Kieffer	Pyriform	High	Sub acidic	M	M rough	M	85.8	6.4	6.3	11.0	0.28	8.3	18.5
Tumaria	Pyriform	V high	Highly sweet	Low	Smooth	Melting	97.5	7.9	6.6	14.5	0.37	8.9	19.3
China	PNN	V high	Highly sweet	Low	Smooth	M	100.8	8.7	6.6	14.3	0.36	8.2	20.5
Sand Pear	Pyriform	M	M sweet	High	M rough	M	72.5	5.0	5.1	14.2	0.27	8.0	13.9
Le Conte	PNN	V high	Highly sweet	Low	Smooth	Soft	98.3	7.9	6.7	15.2	0.17	9.1	19.5
Thumb Pear	Round	V high	Sweet	Low	Smooth	Soft	104.2	5.3	6.6	14.9	0.27	8.9	19.6
SEm±	–	–	–	–	–	–	3.6	0.4	0.3	0.8	0.51	0.4	2.3
LSD (P=0.05)	–	–	–	–	–	–	9.9	0.3	0.3	0.2	0.29	0.3	4.03

M=Medium; V=Very

highly sweet. Grittiness varied in the selected germplasm from low (Pant Pear-3, Pant Pear-6, Pant Pear-9, Tumaria, China, LeConte and Thumb Pear) to medium (Pant Pear-1, Pant Pear-2, Pant Pear-4, Pant Pear-5, Pant Pear-7, Pant Pear-15, Pant Pear-18, Patharnakh, Smith and Kieffer) and high (Pant Pear-10, Pant Pear-13, Mehal and Sand Pear). Melting, soft, medium and hard, melting types of pulp texture were recorded for selected germplasm. Melting type of pulp was observed in Pant Pear-3 and Tumaria and soft pulp in Pant Pear-1, Pant Pear-2, Pant Pear-5, Pant Pear-6, Pant Pear-7, Pant Pear-9, Pant Pear-15, Pant Pear-18, Patharnakh, LeConte and Thumb Pear. Medium pulp texture was recorded in Pant Pear-4, Pant Pear-10, Pant Pear-13, Smith, Kieffer, China and Sand Pear. Hard pulp texture was observed in Mehal only. The findings were in agreement with Prakash (2000) and Singh *et al.* (2001),

Chemical fruit quality and yield parameters

TSS (%) variation was recorded from 9.1% (Mehal) to 15.2% (LeConte). All the germplasm differed significantly with Patharnakh except Pant Pear-7, Pant Pear-15 and Pant Pear-18. The difference in acidity (%) was significant with maximum (0.37%) recorded in Tumaria and minimum (0.17%) in Pant Pear-3 with no significant difference amongst other selected germplasm. Selected germplasm varied in sugar from 6.1% (Mehal) to 9.1% (LeConte). No significant difference was observed amongst Pant Pear-6, Pant Pear-7, Pant Pear-9, China and Sand pear. Whereas other selected germplasm differed significantly with Patharnakh. The highest fruit yield was recorded in Pant Pear-3 (26.5 q/ha) and the lowest in Mehal (10.2 q/ha). Significant fruit yield difference was recorded for Pant Pear-3, Pant Pear-6, Pant Pear-10, Pant Pear-13, Mehal and Sand pear as compared to Patharnakh. The findings were in conformity with Mann and Singh (1985), Kumar (1996), Prakash (2000) and Singh *et al.* (2001),

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