Evaluation of Different Elite Pear (*Pyrus communis* L.) Varieties for North Western Plain Zone of Uttar Pradesh, India

ABSTRACT

The present investigation was carried out at Horticultural Research Centre under Sardar Vallabhbhai Patel University of Agriculture and Technology Meerut, during 2019-2020 and 2020-2021 seasons to select the promising varieties of pear. The experiment was conducted on a 7-8-year-old pear orchard spaced at a distance of 3 m × 4 m. On four varieties i.e. Baggugosa, Punjab Beauty, Punjab Gold and Punjab Nectar and each replicated thrice. Each treatment consisted of three trees with a total of 12 trees. The obtained results showed that the number of flowers per plant, stem girth, number of fruits per plant, fruit weight, fruit length and fruit width were found to be significant. On the other side, number of primary branches and plant height was found to be non-significant. The results of the present study indicate that on the basis of their flowering times, full bloom times and morpho-economic characteristics, Punjab Nectar appeared to be a superior variety in terms of tree morphology and others as moderate. Further, it can be concluded that the variety Punjab Beauty had more productivity and the fruits of Punjab Nectar and Punjab beauty were having more marketable fruit traits.

Keywords: Morpho-economic Characteristics, Marketable Fruit traits, Pear, Pear Quality, Pear Varieties.

Introduction

Pears (*Pyrus communis* L.) are the second most important, widely grown, and produced temperate fruit after apples, and they are very adaptable to a wide range of climatic situation (Janick and Paull 2008). Pear belongs to the family Rosaceae, subfamily Maloideae or Spiraeoideae. The Kashmir Valley and the cooler regions of the Himachal Pradesh and Uttrakhand highlands are where pears are primarily grown in India (Chattopadhyay, 2009). Subtropical regions also support the cultivation of a few mild chilling pear cultivars. When dormant, it can withstand temperatures as low as -26°C and as high as 45°C when in the active development phase. While sub-tropical pears only need 200–300 chilling hours, temperate pears can be grown from low hills to high hills (600–2700 amsl) with 500–1500 chilling hours. Pears are indigenous to temperate and coastal regions of Western Europe and North Africa (Janick and Paull 2008). The pear fruit tree is a medium-sized tree, standing between 10 and 17 metres tall. Simple, alternately placed, 2 to 12 cm long leaves; 2 to 4 cm in diameter, white flowers. Pear fruits range in size from one to four (Brian and Cameron 1995).

A *Pyrus communis* variety native to Europe is called the Carmen pear. It is a hybrid of the Guyot and Bella di Giugno Italian cultivars. Such pears' yields are affected by the quantity and quality of flowers produced, the effectiveness of pollination and fruit set, the severity of naturally occurring or artificially induced abscission of fruitlets, and the degree and rate of cell development and expansion in the persisting fruits.

Pears are rich in essential antioxidants, plant compounds, and dietary fibre (Basu and Rhone 2018). As part of a balanced, nutritious diet, consuming pears could support weight loss and reduce a person's risk of cancer, diabetes, and heart disease. Both macronutrients and micronutrients are rich in pears (Senser et al., 1999). It is a good source of vitamin C and a great source of dietary fibre (Silos et al., 2003). Compared to other fruits and vegetables, it has a higher percentage of nutritional fibre. This fruit's dietary fibre level might be considered a potent food enhancer (McKee and Latner, 2000). Pear is next to apple in importance, in terms of acreage and production it is one of the most important temperate and subtropical fruit crops of Northern India (Singh et al. 2010). It grows wild in temperate regions of Europe, and Western and Central Asia. In India, pear is mainly grown in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Punjab and Haryana. Presently, total pear production in the country is 3.06 lakh tons from an area of 0.42 lakh hectares However, the selection and development of low-chill cultivars had made its cultivation possible in the subtropical region also (Salama et al. 2021). The low chill requiring cultivars like Le Conte, Punjab Beauty, Punjab Gold, Punjab Nector, Gola, Patharnakh and Baggugosha are quite successful in the northern plains of India. These many components that make up the total factor that determines pear yields are themselves controlled by genetic (Scion cultivar and Rootstock), environmental (Climate and Soil), and numerous managerial (Training, Pruning, Plant Growth Regulators) factors. Climate plays a major role in determining the phenology, physiology, distribution, and interactions of plants. Phenology is the study of how biological processes cycle throughout the year (Bradley et al. 1999), and it is thought to be the

component of nature that responds to climate change the most (Sparks and Menzel 2002). Through, the cultivation subtropical varieties of Pear is very small area in western Uttar Pradesh, but no attempt has been made so, far to study the evaluation of different morpho and economic traits of Pear. Hence, the present investigation was undertaken to study the "Evaluation of Different Elite Pear (*Pyrus Communis* L.) Varieties for North Western Plain Zone of Uttar Pradesh".

Materials and Methods

The investigation was conducted at the Horticulture Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram, Meerut, U.P. during the year 2019-2020 and 2020-2021. The experimental field is situated at 29º04' North latitude, 77°42' East longitude, at a height of 237.75 metres above mean sea level. The experimental material consisted of 12 pear trees and all of them were subjected to uniform cultural practices avoiding pruning during the course of experimentation. The experiment was performed on a 7–8-year-old pear orchard spaced at 3×4 m laid out in a Randomized Block Design (RBD) and required parameters were recorded. The number of varieties were four, each replicated 3 times. The cultivars were considered as a factor and each plant under study as a replication four cultivars of Pear were studied namely Punjab Gold collected from PAU, Ludhiana, Punjab Nectar collected from PAU, Ludhiana, Punjab Beauty collected from PAU, Ludhiana and Baggugosa collected from GBPUA&T, Pant Nagar. The daily observations were taken to identify the emergence of the Date to first flowering and the Date to full bloom from March to April. The emergence of the Date to first Flowering and the Date to full bloom duration was calculated by counting the number of days taken by the plant from the anthesis of 1st flower to the last one. The number of flowers produced by each pear variety replication was counted in terms of the total number of flowers per plant. Number of primary branches per plant was counted manually during the trial period and their average value was calculated by dividing the total number of primary branches with the number of plants of each replication of pear varieties. Two directions for canopy spread (North-South and East-West) were used to measure the canopy spread, and the mean diameter was used to calculate the diameter (m). The mature tree's trunk girth (cm) was measured 50 centimeters above the ground. Plant height was calculated by measuring the distance between the base of the tree and the tip of the highest shoot with a long, straight, measured, and marked stick. There were meters listed as its measurements (m). The number of fruits produced by each pear variety replication was counted in terms of the total number of fruits per plant. Five fruits from each cultivar were taken from each replication in to determine the fruit's length, width (in mm), and weight (g). Vernier callipers were used to measure the average length of five fruits from the fruit's base to its tip in order to determine the length of the fruit in each replication. Vernier calipers were used to measure the fruit width in each replication, with the average width of five fruits being measured at their widest point. Five randomly selected fruits from each marked or tagged tree were averaged in each replication to estimate the weights of the fruits. By dividing the total fruit weight by the total fruit number, the fruit values were then calculated. The number of fruits present at the time of harvest is multiplied by the average fruit weight to determine the fruit yield per tree. Using the suggested Panse & Sukhatme (1967) standard approach, the gathered observations were statistically evaluated.

The CD parameters were determined at 5 % level of significance. The co-efficient of variation (CV) in percentage was also worked out.

(1) $SE(m) = \sqrt{EMS/r}$, Where, SE(m) = Standard error of the mean EMS= Error mean square

(2) CD (0.05) = SE(m) x 1.414 x 't'(0.05) value at error degrees of freedom

Where, SE(m) = Standard error of mean, CD = Critical Difference, r = Number of replication

Results and Discussion

The twelve important flowering times, full bloom times and morpho-economic characteristics measured in plant samples are summarized in Table 1 and Table 2. Among the four cultivars studied, the earliest flowering occurred in cv. Punjab Beauty (28 March) while the cv. Punjab nectar flowered last (3 April) in the year 2019-2020 (table 1). In the year 2020-21, the earliest flowering was recorded in cv. Baggugosa (26 March) followed by cv. Punjab Beauty (27 March) and cv. Punjab gold (2 April) but last was observed in cv. Punjab nectar (4 April).

The data further revealed that the maximum number of flowers per plant was born in cv. Punjab Beauty with an average of 124.33 flowers followed by Punjab Gold (98.33), Punjab Nectar (86.66) and Baggugosa (86) in 2019-20. In 2020-2021, maximum number of flowers per plant was observed

in Punjab Beauty (73.66), Baggugosa (58.33), Punjab nectar (55.66) and Punjab Gold (46). The data was found to be non-significant. Facteau et al., 1986 reported that the flowering date and period are subject to change, based on the cultivar's ability as well as ecological and cultural factors. In temperate fruit trees, irregular bud break and development patterns are caused by a lack of chilling, which happens when winters are mild (Lam Yam, 1989; Balandier et al., 1993; Ameglio et al., 2000). The most crucial aspect of a plant's growth that is influenced by the climate is flowering. In temperate fruits grown in the subtropics, in particular, the timing of flowering is determined by the temperature at the time. The availability of low temperatures throughout this fruiting season may have been a contributing factor in the longer flowering period in 2020-2021. Similar findings were also made by Lu et al. (2006), who noted an advance in the flowering dates of different Prunus species as a result of rising temperatures.

Among the four cultivars studied, earliest full bloom was recorded in cv. Baggugosa (7 April) and last was observed in cv. Punjab nectar (10 April) in the year 2019-2020 (Table no. 1). In the year 2020-2021, the same pattern of full bloom was observed with the highest in cv. Punjab Beauty (10 April) and last in the cv. Punjab nectar (16 April).

Table 1. Date of first flowering and full blossom in the year 2019-2020 and 2020-2021

Cultivars	Date to first flowering						Date to full bloom					
Replication	R1		R2		R3		R1		R2		R3	
Year	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021
Baggugosa	29-Mar	26-Mar	29-Mar	26-Mar	29-Mar	26-Mar	07-Apr	10-Apr	07-Apr	12-Apr	08-Apr	11-Apr
Punjab Beauty	28-Mar	27-Mar	28-Mar	27-Mar	28-Mar	27-Mar	10-Apr	09-Apr	07-Apr	10-Apr	07-Apr	09-Apr
Punjab Gold	01-Apr	02-Apr	01-Apr	02-Apr	01-Apr	02-Apr	08-Apr	10-Apr	07-Apr	08-Apr	07-Apr	10-Apr
Punjab Nectar	03-Apr	04-Apr	03-Apr	04-Apr	03-Apr	04-Apr	10-Apr	18-Apr	10-Apr	16-Apr	10-Apr	16-Apr

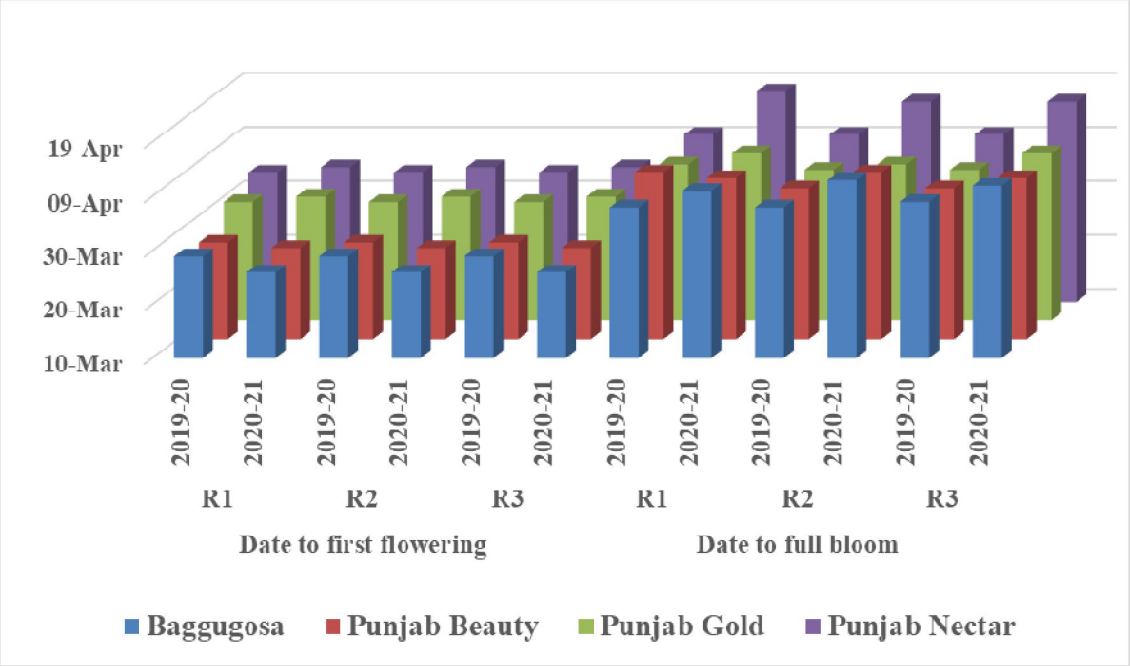

Figure 1. Date of first flowering and full blossom in the year 2019-2020 and 2020-2021

Number of primary branches per plant was found to be non-significant. However, the number of primary branches per plant were almost the same in the year 2019-2020 with the highest in cv. Baggugosa (6), along with cv. Punjab Nectar (6) whereas the cv. Baggugosa (6.33), along with cv. Punjab Nectar (6) showed the highest number of primary branches in 2020-2021.

Canopy spread was also found to be significant in both the years i.e. 2019-20 and 2020-21. In the year 2019-20, cv. Punjab Beauty (3.6 m) showed the maximum area under its canopy followed by cv. Baggugosa (3.16 m), Punjab gold (2.0 m) and Punjab Nectar (1.56 m). However, the cv. Punjab Beauty (3.93 m) showed the maximum canopy spread followed by cv. Baggugosa (3.60 m), Punjab Gold (2.0 m) and Punjab nectar (1.96 m). in the year 2020-21.

Stem girth was found to be non- significant and was maximum in cv. Punjab Beauty (32.66 cm) among all the four cultivars in the year 2019-2020. This was followed by cv. Baggugosa (30 cm), Punjab Nectar (26.33 cm) and Punjab Gold (23.33 cm). In the year 2020-2021, similar pattern was observed with the cv. Punjab Beauty (31 cm) having the maximum stem girth followed by Baggugosa (30 cm), Punjab Nectar (28.66 cm) and Punjab Gold (19 cm).

Cultivar Punjab Beauty (6.29 m) showed the highest plant height in the year 2019-2020, while the shortest plant height was reported in cv. Punjab Nectar (4.31 m) in the same year. Cultivar Baggugosa and cv. Punjab Gold reported the plant height of 5.51 m and 4.31 m respectively in the year 2019-20. In the year 2020-2021, Punjab Beauty (7.64 m) again showed the maximum plant height followed by cv. Baggugosa (6.50 m), Punjab gold (5.95 m) and Punjab Nectar (5.01 m). The data was found to be significant.

The maximum number of fruits per plant in the year 2019-20 were produced by cv. Punjab Beauty (34) followed by cv. Punjab Nectar (29.33), Punjab Gold (26.66) and Baggugosa (16.66). Whereas, Cultivar Punjab nectar produced maximum number of fruits per plant in the year 2020-2021 i.e. 86.66 and was followed by Punjab Beauty (66.66), Baggugosa (55) and Punjab Gold (27.66). The obtained data was found to be significant.

Fruit size is a key criterion for selecting superior genotypes in breeding programmes (Westwood and Blaney, 1963). The length of the fruit was found to be longest in cv. Punjab Beauty (73.84 mm) in the year 2019-20. In the same year, the other three cultivars, namely, Punjab Nectar, Baggugosa and Punjab Gold showed 72.64 mm, 72.20 mm and 71.18 mm fruit length, respectively. In the year 2020-21, the cv. Punjab Beauty (73.84 mm) reported the longest fruit length followed by cv. Punjab Nectar (67.37), Baggugosa (61.89) and Punjab Gold (60.79). The data was found to be non- significant.

Fruit size in width was found to be highest in cv. Baggugosa (57.54 mm) in the year 2019-20 and was further followed by cv. Punjab Nectar (54.62 mm), Punjab beauty (54.01 mm) and Punjab Gold (51.51 mm). However, in the year 2020-21, the cv. Punjab Gold (65.50 mm) produced fruits with highest width and was followed by cv. Punjab Nectar (55.33 mm), Baggugosa (52.14 mm) and Punjab Beauty (48.56 mm). The obtained data in this experiment was found to be significant.

Harada et al. (2005) reported that fruit size and weight may be influenced by genetic variables relating to their phylogenic behavior. Fruit weight per fruits revealed that in the year 2019-20, cv. Baggugosa (135 g) produced the heaviest fruit. This was further followed by Punjab Beauty (121.66 g), Punjab Gold (113.33 g) and Punjab Nectar (105.0 g) in the same year. However, in the year 2020-2021, cv. Punjab Beauty (123.33 g) produced the heaviest fruit among the four cultivated cultivars followed by Punjab Gold (121.66 g), Punjab Nectar (108.33 g) and Baggugosa (95 g). The data was found to be significant. (Stanley et al. 2000) outlined that the genetic, environmental and cultural behaviors, all interact to determine fruit weight. Producing larger fruits could be due to a genotype's innate ability to efficiently use resources to reach a specific fruit size. The normal growth and development, flowering behaviour, fruit quality, and pest and disease incidence have all been impacted by changing climatic conditions. The lack of regularity and blossoming in trees are both impacted by low winter chill. More attention should be focused on developing heat and drought tolerant cultivars in consideration of the possible effects of climate change. Understanding the variability in the patterns of climate change is crucial. Production of pears is seriously threatened by the current climate changes, which include temperature fluctuations, precipitation, ground frost, and related adversities such as the spread of pests and diseases, decreased soil fertility, and decreased water availability. As a result of climatic change, production decreased from 10.8 to 5.8 tonnes per acre in apple (Awasthi et al., 2001). Due to high temperatures and cold waves, many fruit crops are badly impacted (Malhotra, 2017). Insufficient

chilling can lower the pollination of cross-pollinated fruits like pistachios and walnuts, which lowers crop yields and severely cold waves, horticultural crops face a 10-to-100 percent return loss depending on the crops and varieties (Hazarika, 2013). Climate change causes a number of abiotic effects, which in turn affect several horticulture fruit crops and their physiological, anatomical, morphological, and biochemical properties. The greatest impact on fruit production comes from environmental conditions such temperature, drought, salt, flooding, an increase in CO2 concentration, and the emergence of insect pests (Gora et al., 2019).

Table 2. Evaluation of Different Elite Pear (*Pyrus communis* L.) Varieties on the basis of Morpho-economic Characteristics

Varieties/ Characters	Baggugosa		Punjab Beauty		Punjab Gold		Punjab Nectar		CD		CV	
Year	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021	2019-2020	2020-2021
Number of Flowers per Plant	86	58.33	124.3	73.66	98.33	46	86.66	55.66	24.39	N.S.	12.38	35.68
Number of Primary Branches	6	6.33	5	6	4.66	4	6	6	N.S.	1.52	17.27	13.68
Canopy Spread (m)	3.16	3.6	3.6	3.93	2	2	1.56	1.96	0.56	0.72	10.89	12.61
Stem Girth (cm)	30	30	32.66	31	23.33	19	26.33	28.66	6.26	N.S.	11.79	17.42
Number of Fruits/Plant	16.66	55	34	66.66	26.66	27.66	29.33	86.66	5.91	18.8	11.12	15.99
Plant Height (m)	5.56	6.5	6.29	7.64	5.51	5.95	4.31	5.01	N.S.	1.05	14.81	8.41
Fruit Weight (g)	135	95	121.6	123.3	113.3	121.6	105	108.3	10.63	N.S.	4.49	16.27
Fruit Length (mm)	72.2	61.89	73.84	74.1	71.18	60.79	72.64	67.37	N.S.	N.S.	4.73	7.46
Fruit Width (mm)	57.54	52.14	54.01	48.56	51.51	65.5	54.62	55.33	N.S.	8.05	5.73	7.29
Fruit Yield per Plant(Kg)	2.16	5.03	4.13	8.26	3.05	3.4	3.05	9.42	0.15	0.94	2.49	7.29

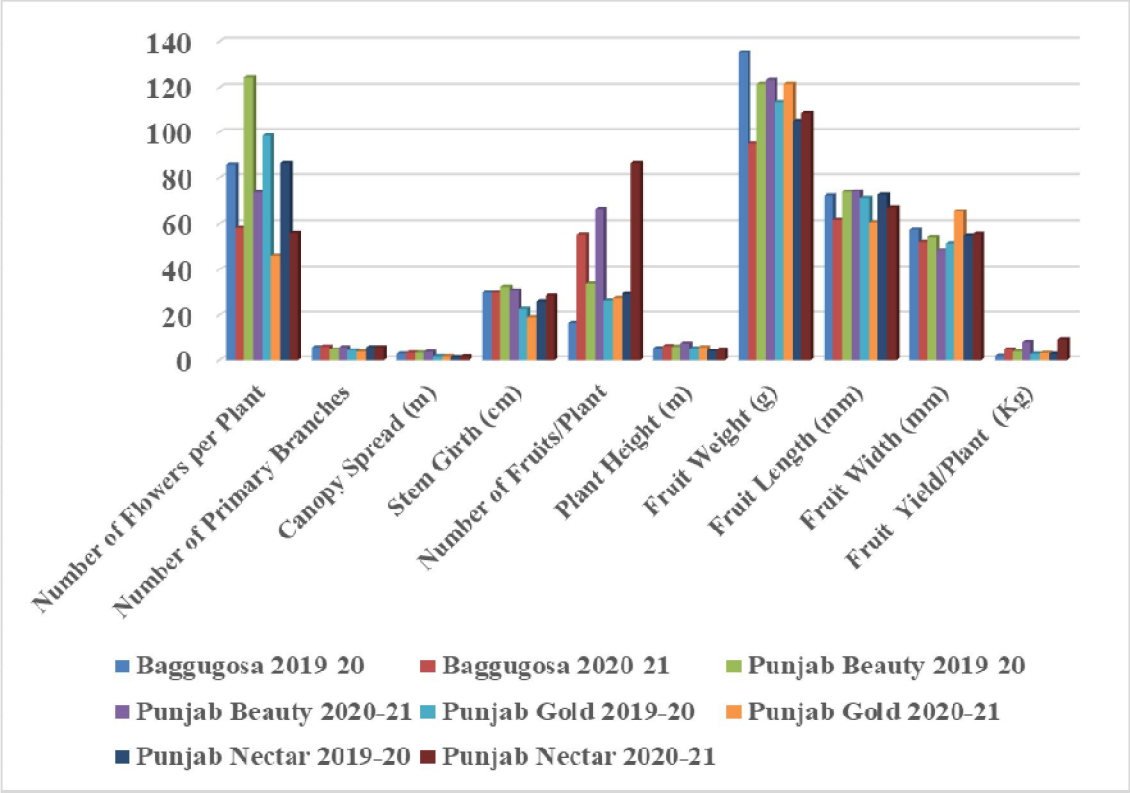

Figure 2. Evaluation of Different Elite Pear (*Pyrus communis* L.) Varieties on the basis of Morpho-economic Characteristics

Conclusion:

All four varieties tested in the experiment were found to be promising for cultivation under the North-Western Plain Zone of Uttar Pradesh and can further be recommended for research trials, mass multiplication programmes and ultimately adoption by the farmers and orchardists. On the basis of flowering times, full bloom times and morpho-economic characteristics Punjab Nectar appeared to be a more promising and superior variety in terms of tree morphology and others were found to be moderate. Therefore, it can be concluded that the fruits of Punjab Nectar and Punjab Beauty had more marketable fruit traits. The present study also confirms that there is much diversity in pear cultivars studied in this experiment, and hence, it becomes necessary to preserve and conserve these unique genetic resources for future breeding programmes for the development of innovative, market-driven cultivars for future.

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Disclosure statement

The author(s) declared no potential conflict of interest.

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