DOI : 10.5958/0974-0112.2015.00065.1

Indian J. Hort. 72(3), September 2015: 334-337

Performance of papaya cultivars grown under protected conditions

Manu Tyagi*, Harminder Singh and S.K. Jawandha

Department of Fruit Science, Punjab Agricultural University, Ludhiana 141004

ABSTRACT

Papaya is an important fruit crop of tropical region. However, it can be grown successfully in the sub-tropical regions of north India with suitable precautions. The major limitations in papaya cultivation on commercial scale in Punjab include dioecious nature of varieties, extremes of temperature, frost, water-logging causing wilt and susceptibility to viral diseases (leaf curl and mosaic). These problems can be managed to some extent by growing plants under protected conditions. In the present study, plants of five papaya varieties, namely, Surya, Madhu, Arka Prabhath, Pusa Dwarf and Red Lady 786 were evaluated under poly-nethouse in 2012 and analysed for yield and various physico-chemical fruit traits. The results revealed significant variations in fruit number (20.47-46.00), yield (10.49-38.84 kg), fruit weight (508.00-841.67 g), TSS (8.0-13.0%) and total sugars (3.0-7.9%). However, no significant variations were observed in terms of edible portion, fruit firmness and titrable acidity. The highest yield (38.84 kg) and best fruit quality traits in terms of fruit weight (841.67 g), TSS (13.0%) and total sugars (7.9%) were found in the variety Red Lady 786.

Key words: Papaya, yield, physico-chemical traits, poly net house.

INTRODUCTION

Papaya popularly termed as wonder fruit, is the choicest fruit of tropics and sub-tropics. The limited cultivation of this fruit on commercial scale by the farmers in north India is mainly attributed to the adverse effects of biotic and abiotic factors like low temperature, frost injury and viral diseases. Apart from yield, the low temperature also hampers the fruit quality. Generally, the flowering coinciding with extreme winter temperatures lead to the development of fruits, which are poor in texture, firmness and lack sweetness. This may be attributed to the poor synthesis and accumulation of total sugars in the fruit due to the non-availability of sufficient heat units. Such fruits attain poor acceptance in market and thus incur heavy losses to the farmers. The protected cultivation technology can however, serve a solution to these constraints. Furthermore, the high temperatures existing inside the greenhouse, aid in the development of improved quality fruits even during winters, in comparison to open field grown papaya fruits.

In India, the commercial production through protected cultivation is barely three decade-old. But with the consistent support of government and state universities, it is expected that the area under protected cultivation may accentuate to about 84.2 per cent for the period from 2013 to 2017 (Paroda, 6). There is a wide scope of raising tropical fruit crops like papaya, banana and pineapple through protected cultivation technology. In sub-tropics, the papayas grow and fruit better under greenhouses. In Canary Islands over 150 hectares of papaya are already grown under greenhouses (Sauco, 8). The commercial cultivation of greenhouse papaya is also being carried in Japan and Israel. However, in India not much work has been carried in this aspect. For these reasons, the present study was conducted to ascertain the performance of five papaya varieties under protected conditions in the sub-tropics of India.

MATERIALS AND METHODS

The present study was conducted at Punjab Agricultural University, Ludhiana during the year 2013-14. Nine plants of five varieties, *viz.*, Madhu, Pusa Dwarf, Surya, Arka Prabhath and Red Lady 786, were grown under poly net house and analysed for their yield and physico-chemical characteristics like fruit length, breadth, fruit weight, fruit shape, total soluble solids, total sugars and titrable acidity. The fruit skin as well as flesh colour were analysed through Royal Horticultural Society Colour Chart (Wilson, 9). The flesh firmness was computed using 'fruit pressure tester' penetrometer. About one square centimetre of the peel in each fruit from the shoulder end on both sides was removed by peeler and firmness of pulp was recorded by inserting to a depth of 2 mm into the fruit. Erma hand refractometer was used to determine total soluble solids content of strained juice. The total sugars content was estimated by the method of AOAC (1) by titrating

*Corresponding author's present address: Department of Horticulture, GBPUA&T, Pantnagar, Uttarakhand; E-mail: manutyagi89@gmail.com

against boiling Fehling's solution (5 ml A + 5 ml B) using methylene blue as indicator. The titrable acidity was determined by titration against N/10 NaOH solution using phenolphthalein as an indicator. The experiment was laid under randomized block design with three treatments and each treatment included three plants. Three fruits were randomly picked from each plant for analysis. The data was analysed by Least Square Design (LSD) using SAS (Statistical Analysis System) and significance level was determined at $P \leq 0.05$.

RESULTS AND DISCUSSION

The results in relation to the yield parameters of different papaya varieties are mentioned in Table 1. The study reveals that among the five varieties, the harvesting was earliest in Red Lady 786, which took least number of days (295) while the fruits of Arka Prabhath took maximum number of days (388) to harvest. The remaining varieties, *viz.*, Madhu, Pusa Dwarf and Surya took 322, 343 and 372 days to harvest under protected conditions in the present studies. This result is in accordance with Ram (7) who had reported that the papaya fruits attain full size and mature in about 3 to 5 months after fruit set. Further single fruits per node was registered in each variety, which excluded the need of thinning.

The average number of fruits of papaya varieties differed significantly among each other. The highest number of fruit was recorded in Red Lady 786 (46.0) followed by Madhu and Surya, which recorded 36.67 and 30.67 fruits per tree. The variety Arka Prabhath produced the lowest number of fruits (20.66) per tree. The average number of fruits/tree in Pusa Dwarf was 23.66 when an average of both male and female plants was taken together. However, on female plants average fruit number/tree was found to be 47.33 (as the percentage of female plants was 50%). Further, the highest yield (38.84 kg) was recorded in variety Red Lady 786, which was found to be at par with Madhu (30.56 kg). The lowest yield /tree (10.49 kg) was witnessed in Arka Prabhath, which was at par with Pusa Dwarf and Surya (17.53 and 15.48 kg, resp.) Similar findings were reported by Kumar *et al.* (3) and Jana *et al.* (2) in variety Pusa Dwarf. In contrast to these results, Nguyen *et al.* (5) recorded low number of fruits in Red Lady 786 under Vietnam conditions. These differences might be attributed to different geographical conditions. Moreover, these evaluations were carried in open conditions unlike the present study. The protected environment may be responsible for better vegetative and reproductive growth of the plants as compared to open conditions.

The results on physical parameters of fruits of different papaya varieties are summarized in Table 2. The data reveals significant variations in fruit weight, fruit length and central cavity diameter. However, no significant variation was witnessed in fruit breadth. The maximum fruit weight (841.67 g) was recorded in Red Lady 786 closely followed by Madhu (834.50 g) and Pusa Dwarf (758.67 g). The fruit weight of Arka Prabhath (508 g) was found to be lowest among all the varieties succeeded by Surya (512.67 g). The fruit length varied from 11.33 to 15.33 cm. The maximum fruit length (15.33 cm) was observed in the variety Red Lady 786, while the minimum (11.33 cm) was found in the varieties Pusa Dwarf and Surya. The mean fruit diameter was highest in Red Lady 786 (12.31 cm) followed by Madhu and Pusa Dwarf, which recorded a diameter of 10.33 and 9.33 cm, respectively. The fruits of Surya were found as smallest with a mean diameter of 6.9 cm. The variations among the varieties may be attributed to their genetic constitution. The differential ability of photosynthetic rate per unit leaf area per unit time can also be responsible for the varied fruit weight.

Earlier, Nguyen *et al.* (5) reported that the fruit shape in papaya to be a sex-linked trait. The pistillate flower is characterised with a globous ovary that develops into round or ovoid fruit, while the hermaphrodite flower exhibits a slender ovary, which develops into elongated, cylindrical and pyriform

Table 1. Maturity, yield and chemical parameters of different papaya varieties under protected conditions.

Variety	Start of harvest	Days taken to harvesting	No. of fruits per node	No. of fruits/tree	Yield/tree (kg)	Total soluble solids (°B)	Total sugars (%)	Titrable acidity (%)
Surya	27 October	372	1	30.67	15.48	12.00	5.42	0.06
Madhu	7 September	322	1	36.67	30.56	8.06	3.0	0.07
Pusa Dwarf	28 September	343	1	23.66	17.53	8.73	3.31	0.09
Arka Prabhath	13 November	388	1	20.67	10.49	10.00	3.90	0.05
Red Lady 786	10 August	295	1	46.00	38.84	13.00	7.91	0.10
$LSD_{(0.05)}$	_	5.07	NS	7.74	8.60	1.49	1.36	NS

Table 2. Physical parameters of different papaya varieties under protected conditions.

Variety	Fruit wt. (g)	Fruit length (cm)	Fruit dia. (cm)	Central cavity dia. (cm)	Fruit shape	Fruit peel colour	Fruit pulp colour	Fruit firmness (lb)	Edible portion (%)	Organoleptic score	No. of seeds/ fruit
Surya	512.67	11.33	6.90	5.90	Elliptic	Orange group 24 A	Orange group 28 B	1.20	84.79	7.8	30.00
Madhu	834.50	14.56	10.33	6.65	Oval	Yellow Orange group 23 A	Orange group 29 A	1.66	81.20	7.0	35.66
Pusa Dwarf	758.67	11.33	9.33	5.70	Oval	Yellow Orange group 23 B	Yellow Orange group 15 A	1.20	85.31	7.4	71.66
Arka Prabhath	508.00	12.36	8.03	3.80	Blosom end tapered	Yellow Orange group 21 B	Orange group 28 B	0.73	83.54	7.0	35.66
Red Lady 786	841.67	15.33	12.31	6.66	Oblong & Oval	Orange group 24 B	Orange Red group 32 A	1.18	84.49	8.6	39.33
$LSD_{(0.05)}$	138.24	2.51	NS	1.46	–	–	–	NS	NS	NS	17.15

shape. The results of present study showed that there were two fruit shapes for Red Lady 786. As mentioned above, the fruits from pistillate flowers were oval, while an oblong shape was found in the fruits: derived from hermaphrodite flower. The fruits of Pusa Dwarf variety were oval or round shaped. This may be because Pusa Dwarf is a dioecious variety with only pistillate flowers on female plant. The fruits of local variety Madhu were also characterised with an oval shape. A major proportion of fruits in Arka Prabhath were governed with a blossom end tapered shape, while the fruits of Surya exhibited an elliptic shape. There were two types of peel colours among the varieties. Varieties Madhu, Pusa Dwarf and Arka Prabhath had a yellow-orange peel colour, while Surya and Red Lady 786 exhibited orange coloured peel. The pulp colour varied from orange-red in Red Lady 786 to yellow-orange in Pusa Dwarf.

The susceptibility of a fruit to physical or mechanical damage is a function of its firmness. All the papaya varieties registered no significant variation for fruit firmness or per cent edible portion. The highest edible portion (85.31%) was found in Pusa Dwarf followed by Red Lady 786. On the basis of pulp colour, flavour, sweetness and sourness, the variety Red Lady 786 gained highest overall acceptance and was termed as extremely desirable with a score of 8.6. The average number of seeds per fruit ranged from 30.00 to 71.66. The highest number of seeds per fruit (71.66) was found in Pusa Dwarf. The lowest seed content (30) was exhibited by Surya. Further, no seeds were observed in plants having female flowers.

The data pertaining to the chemical parameters, *viz.*, total soluble solids, total sugars and titrable acidity is mentioned in Table 2. Significant differences were observed in the total soluble solids and total sugars in the fruits of the papaya varieties. Among the varieties, the highest total soluble solids content (13°Brix) and total sugars (7.91%) were recorded in Red Lady 786, which might be attributed to its high photosynthetic efficiency and fast rate of diversion of sugars from source (leaf) to sink (fruit), in comparison to other varieties. Kwame (4) reported that sugar forms the main component of soluble solids in ripe papaya. Therefore, the high amount of total soluble solids in Red Lady 786 may be attributed to its high sugar content. In contrast, the variety Madhu recorded the lowest amount of total soluble solids (8.06°Brix) and total sugars (3%). No significant differences were observed in titrable acid content of different papaya varieties. From the present studies, it was concluded that the variety Red Lady 786 to outperformed the other varieties in terms of yield, maturity and fruit quality under protected conditions.

REFERENCES

1. A.O.A.C. 1980. *Official Methods of Analysis of Analytical Chemists*, Association of the Official Analytical Chemists, Washington, D.C.
2. Jana, B.R., Rai, M., Nath, V. and Das, B. 2010. Promising (*Carica papaya* L.) varieties for subtropical plateau region of eastern India. *Acta Hort.* **851**: 131-35.
3. Kumar, R.K., Kumar, S. and Kumar, R.A. 2007. Morphological performance of indigeneous dioecious papaya hybrids under tropical conditions of India. *South Indian Hort.* **55**: 110-18.
4. Kwame, T.P. 2012. Effect of length of peduncle on quality of Solo papaya fruit during ripening. M.Sc. thesis, Nakrumah University of Science and Technology, Ghana.
5. Nguyen, A.T., Pham, N.T., Nguyen, T.B.H. and Nguyen, V.H. 2011. Evaluating agronomic characteristics of twelve local papaya (*Carica papaya* L.) varieties in Viet Nam. *Bull. Inst. Trop. Agr.* **34**: 15-22.
6. Paroda, R.S. 2013. Strategies of protected cultivation. **In**: *Advances in Protected Cultivation*. *Proc. Natl. Sem*. 21 March, 2013, Indian Agricultural Research Institute, New Delhi, pp. 1-12.
7. Ram, M. 2009. Ripening, harvesting and yield. **In**: *Papaya*, Directorate of information and Publications of Agriculture, ICAR, New Delhi, 102 p.
8. Sauco, G.V. 2002. Greenhouse cultivation of tropical fruits. *Acta Hort.* **575**: 727-33.
9. Wilson, R.R. 1963. *Horticultural Colour Charts*, Wilson Colours Ltd. in collaboration with Royal Horticultural Society and British Council.

Received : November, 2014; Revised : June, 2015;
Accepted : July, 2015